ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

NOVEMBER 9, 1939

NOV 13 1939

... with a hydraulic plant mounted on a crawler-belt carriage for mobility. See p. 42.

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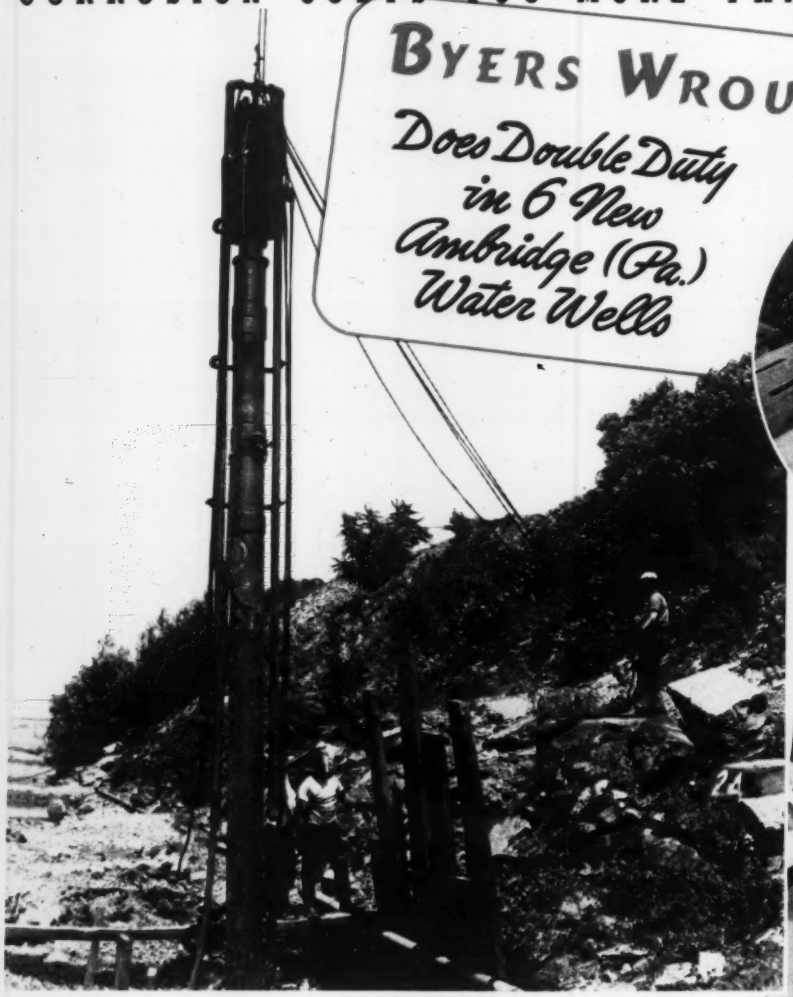
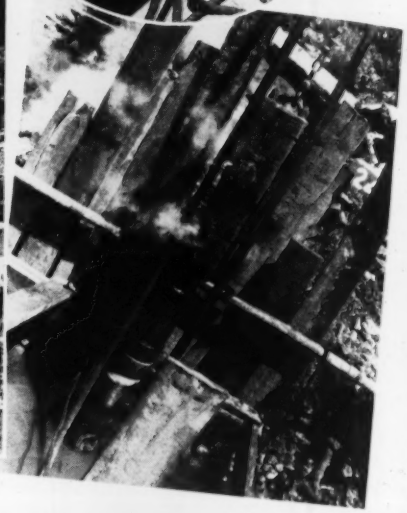
CORROSION COSTS YOU MORE THAN WROUGHT IRON

BYERS WROUGHT IRON

Does Double Duty in 6 New Ambridge (Pa.) Water Wells





WELL CASING ✓ . . STRAINERS ✓

The corrosive attack that can generally be expected from the purest natural waters is aggravated, along the Ohio River, by pollution from mine seepage and industrial wastes. When the Borough of Ambridge, Pa., needed an immediate increase in waterworks pumping capacity, the engineers—with an eye to these severe corrosive conditions—purchased Byers Wrought Iron for Well Casing and Strainers in each of the six new wells.

The versatility of wrought iron was again demonstrated in this job, when the lower section of well casing was fabricated as a water strainer by cutting 143 slots, each ½" x 6", thirteen to a row in eleven alternately staggered rows. Holes were drilled at the ends of each slot, and intervening metal removed with a cutting torch.

Experiences like this may suggest an easy, economical solution of some of your corrosion problems . . . not necessarily in water wells alone, but any place where premature failure of tank or piping materials is causing you trouble and expense. If you have such a problem, and will write us the details, our Engineering Service Department will (1) Determine the probable corrosive conditions; (2) Relate these to similar conditions encountered elsewhere; (3) Interpret the results in the light of 75 years' experience with corrosion problems; and (4) Make recommendations . . . supported by service records. For a quick and graphic picture of the many places where Byers tubular and flat rolled products are *proving* that corrosion costs more than wrought iron, ask for a complimentary copy of our bulletin, "101 Uses for Wrought Iron."

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

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TUBULAR AND FLAT ROLLED PRODUCTS

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THIS WEEK

● Shasta Dam took a prominent place in news of the construction world last week when the Bureau of Reclamation approved the use of a 9-mile belt conveyor system to deliver concrete aggregates to the dam. The first article in this issue reports progress on the dam itself and the new rail line around the reservoir.

● Looking back 50 years, M. N. Baker on p. 53, give an interesting review of significant changes in waterworks practice since he began work on his monumental "Manual of American Water Works."

● Construction methods employed in the rebuilding of Thomas Circle in Washington are given in a staff report of the first attempt to improve traffic conditions at the famous circles in the nation's capital. This article supplements one published Oct. 26.

● Domed roofs of striking appearance have been built over sewage beds at Hibbing, Minn., to protect them against cold. Both design details and construction methods are given on p. 59. Following is brief comment on the significance of these covers to the sanitary engineer.

● A bold experiment designed to end cracking in concrete pavement, made recently by the Missouri highway department, is reported on p. 62. Compressive stress is developed in the green concrete by inflating hose in the expansion joints.

● The famous rubber pavement on the Michigan Ave. Bridge at Chicago has been replaced. Details of the new pavement are given on p. 68.

THINGS TO COME

SUPERHIGHWAYS and subways for Chicago are the subject of two voluminous reports recently made public. A readable summary of the reports will be published Nov. 23.

BEGINNING Nov. 23 is a series of three articles entitled "The City's Sewage Goes to Sea" which is a compilation of available data on the best practice in the design and operation of large outfall sewers.

DIVIDED highways now coming into wide use are to be the subject of a series of articles beginning Dec. 7 which will report current practice in design.

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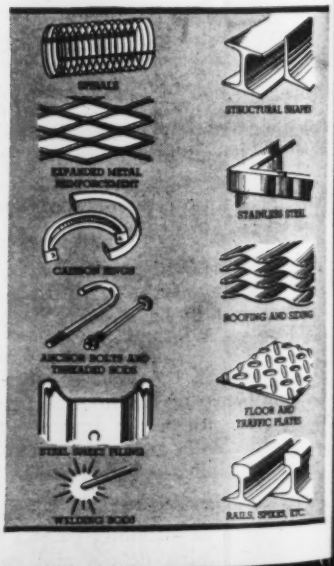
Ryerson Engineers understand the contractor's problems. They are posted on new and improved methods of construction. Let them work with you on your next job. Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.



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CONTRACTS AND CAPITAL

ENR CONSTRUCTION VOLUME AND NEW CAPITAL . . . FHA MORTGAGES

(000 omitted)	October 1938	October 1939	% Change	Ten Months 1938	Ten Months 1939	% Change
Total	$235,898	$245,062	+4.0	$2,235,658	$2,510,314	+12.0
Private	58,026	107,727	+86.0	695,341	717,533	+3.0
Public	177,872	137,335	−23.0	1,540,317	1,792,781	+16.0
Federal	36,350	44,897	+23.0	298,310	296,684	−0.5
Total New Productive Capital	$207,596	$54,474	−74.0	$3,352,450	$2,251,042	−33.0
Private Investment	99,081	25,505	−74.0	849,557	637,322	−25.0
Federal (non-federal work)	108,465	28,969	−73.0	1,359,248	485,692	−64.0
Federal (federal work)	50	.....	.....	1,143,645	1,128,028	−1.0
FHA Mortgages Selected for Appraisal	$97,467	$89,674*	−8.0	$849,539	$965,837*	+14.0

* *Preliminary.*

CONSTRUCTION COSTS . . . WAGE RATES . . . PRICES

	November 1938	November 1939	% Change	Change Oct. to Nov. 1938 Oct.	1938 Nov.	1938 %	1939 Oct.	1939 Nov.	1939 %
ENR Construction Cost Index, 1913 = 100	234.40	238.20	+1.6	234.30	234.40	....	236.86	238.20	+0.6
ENR Building Cost Index, Index, 1913 = 100	195.58	201.24	+2.9	195.48	195.58	+0.1	198.50	201.24	+1.4
ENR 20-CITIES' AVERAGE									
Common Labor	$0.682	$0.685	+0.4	$0.682	$0.682	0	$0.685	$0.685	0
Skilled Labor (Av. 3 Trades)	1.427	1.463	+2.5	1.427	1.427	0	1.444	1.463	+1.3
Bricklayers	1.514	1.563	+3.2	1.514	1.514	0	1.538	1.563	+1.6
Struct. Ironworkers	1.479	1.519	+2.7	1.479	1.479	0	1.499	1.519	+1.3
Carpenters	1.288	1.306	+1.4	1.288	1.288	0	1.296	1.306	+0.8
Cement, per bbl	$2.57	$2.60	+1.2	$2.57	$2.57	0	$2.60	$2.60	0
Reinforcing steel, per cwt	2.48	2.56	+3.2	2.50	2.48	−0.8	2.42	2.56	+5.8
Struct. steel, base	2.10	2.10	0	2.10	2.10	0	2.10	2.10	0
Sand, per ton	1.24	1.20	−3.3	1.24	1.24	0	1.20	1.20	0
Lumber, 2x4 Fir, per M ft	32.38	35.09	+8.4	32.40	32.38	−0.1	33.72	35.09	+4.1
Lumber, 2x4 Pine, per M ft.	28.59	31.77	+11.2	28.39	28.59	+0.7	30.68	31.77	+3.6
Brick, Common, per M	13.87	14.39	+3.7	13.81	13.87	+0.4	14.22	14.39	+1.2
Ready-mixed Concrete, c.y.	7.13	7.10	−0.4	7.12	7.13	+0.1	7.10	7.10	0
Struct. Clay Tile, 3x12x12	74.08	73.68	−0.5	74.24	74.08	−0.2	73.53	73.68	+0.2
Paving Asphalt, cars, ton	14.11	13.77	−2.4	14.85	14.11	−5.0	13.77	13.77	0

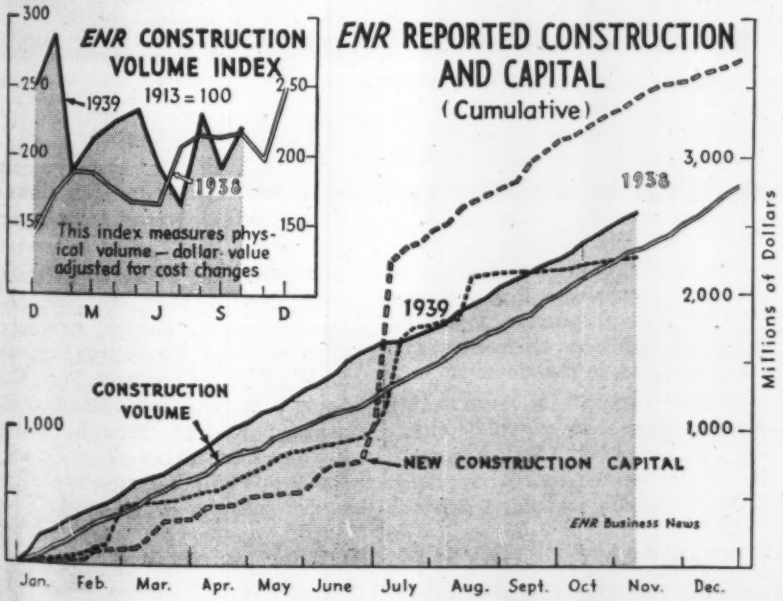
MATERIAL SHIPMENTS . . . BUILDING PERMITS

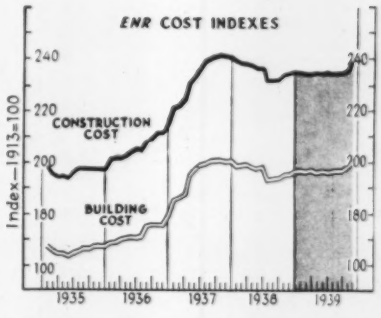
	October 1938	October 1939	% Change	Sept. 1939	% Change Sept.-Oct.
Lumber (% 1929 seas. wk. av.) N.L.M.A.	65.5	79.0	+20.6	73.8	+7.1
Steel (% operating capacity) A.I.S.I.	73.0	89.5	+22.6	51.8	+72.8

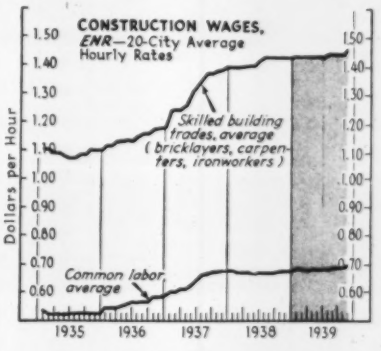
	September 1938	September 1939	% Change	Nine Months 1938	Nine Months 1939	% Change
Fabricated Struct. Steel, tons, A.I.S.C.	93,553	136,278	+45.7	847,402	1,049,206	+23.8
Cement, thous. bbl. U.S.B. of M	11,716	13,104	+11.8	79,313	92,527	+16.7
Building Permits, Dun & Bradstreet, (,000 omitted)	$101,801	$103,210	+1.4	$871,190	$945,182	+8.5

RENT INDEX . . . EMPLOYMENT

	September 1938	September 1939	% Change	Aug. 1939	% Change Aug.-Sept.
Rent (Housing) Index, N.I.C.B.	86.6	86.5	−0.1	86.3	+0.2
All Trade Unions, % Employed, A.F.L.	84.0	89.0	+6.0	88.0	+1.1
Building Trades, % Employed, A.F.L.	68.0	75.0	+10.3	75.0	0






CONSTRUCTION WAGES,
ENR—20-City Average Hourly Rates
Dollars per Hour
Skilled building trades, average (bricklayers, carpenters, ironworkers)
Common labor average
1935 1936 1937 1938 1939

CONTRACTS

(Thousands of dollars)

	Week Ending Nov. 10 1938	Nov. 2 1939	Nov. 9 1939
Federal	$5,803	$8,268	$5,725
State & Municipal	26,149	23,017	27,402
Total public	$31,952	$31,285	$33,127
Total private	5,308	18,755	20,476
TOTALS	$37,260	$50,040	$53,603
Cumulative 1939 (45 weeks)			$2,613,957
1938 (45 weeks)			$2,343,931

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 45 Wk.	1939 45 Wk.
NON-FEDERAL	$2,347,412	$1,135,239
Corp. securities	349,932	193,510
State & Mun.	548,961	452,783
R.E.A. loans	67,495	89,445
R.F.C. loans	100,344	7,854
P.W.A. allot.	814,126	.....
U.S.H.A. loans	265,054	201,647
Fed. Aid—Hwys.	201,500	190,000
FEDERAL	$1,143,645	$1,128,028
TOTAL CAPITAL	$3,491,107	$2,263,267

FHA MORTGAGES

	Week Ending Nov. 5 1938	Oct. 28 1939	Nov. 4 1939
Selected for appraisal	$21,349	$21,783	$20,400*
Cumulative 1939 (44 weeks)			$986,310*
1938 (45 weeks)			$873,112

* Subject to revision.

ENR INDEX NUMBERS

	Construction Cost			Building Cost		Volume	
Base = 100	1913	1926		'13	'26	'13	'26
Nov., 1939	238.20	114.50		201.24	108.95	...	...
Oct., 1939	236.86	113.87		198.50	107.31	222	97
Sept., 1939	234.97	112.95		196.61	106.28	190	83
Nov., 1938	234.40	112.69		195.58	105.71	199	87
Oct., 1938	234.30	112.63		195.48	105.67	217	95
1938 (Av.)	235.86	113.34		196.83	106.40	197	86
1937 (Av.)	234.71	112.66		196.15	106.07	172	75
1936 (Av.)	206.42	99.15		172.18	93.14	185	81
1935 (Av.)	196.44	94.42		165.76	89.65	134	59

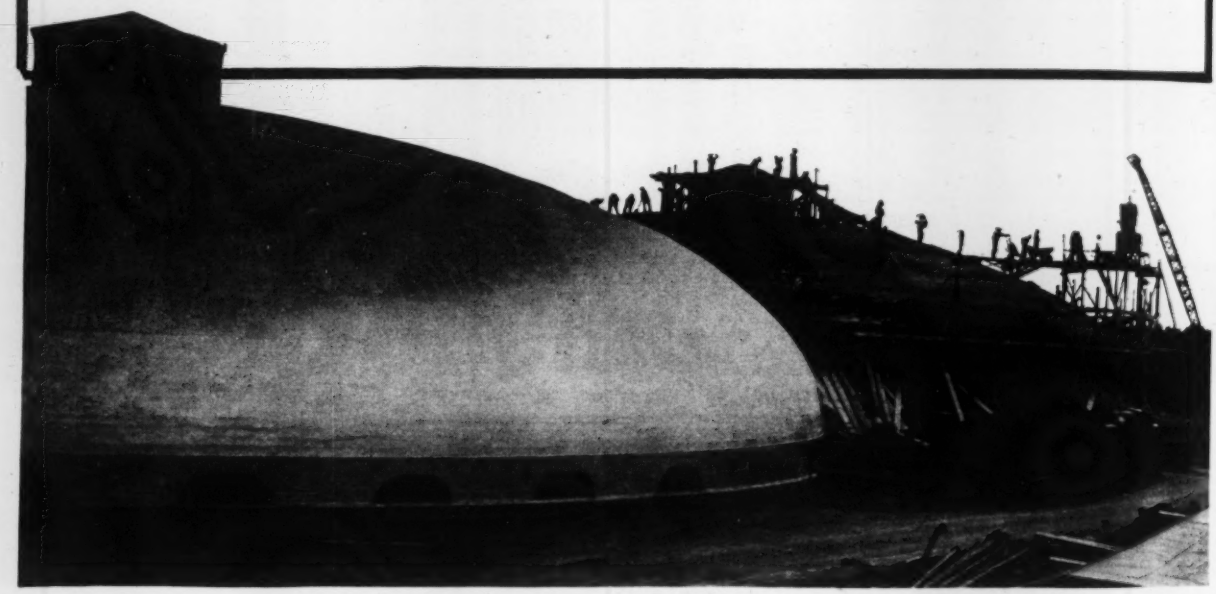
October Construction Table on page 43

COUNTRY'S LARGEST

Z-D DOMES

built with

UNIVERSAL ATLAS CEMENT



A 150-foot span with only a 32-foot rise; a shell as thin as 3½ inches; a dome with no horizontal thrust at the base—these are among the features of two Z-D domes for the trickling filter buildings at the Hibbing, Minnesota, sewage disposal plant.

This dome presented a problem: A dome consisting of a 150-foot hemisphere would require a 75-foot rise; a shallow section of a sphere would have a strong horizontal thrust. But, by using, instead, an elliptical cross section, there is only a 32-foot rise, no horizontal thrust at the base, less dead weight, and less material.

Exterior forms were used only in the lower 12 feet of the shell. Concrete made with Universal Atlas Cement was placed in two layers—a lower layer with a 4-inch slump and an upper layer with a 2-inch slump. The 334 yards of concrete for the first dome were placed in three days; and for the second, in two days.

Because the shell thickness is only 1/500th of the span, careful decentering was necessary. Total downward movement at the top of the dome after decentering was only 1/8th inch or 1/15000th of the span.

The disposal plant system consists of eleven concrete building units in all of which Universal Atlas Cement was used.

Roberts and Schaefer Company, Designers of Concrete Shell Z-D System; J. C. Taylor, Architect; Charles Foster, Consulting Engineer; E. W. Coons Company, Inc., Contractor; W. C. Jones, Resident Engineer; Jas. H. Rough, Village Engineer; Roy C. Pascoe, Project Engineer.

NR-AC-7

UNIVERSAL ATLAS CEMENT COMPANY, CHRYSLER BUILDING, N.Y.C.

(UNITED STATES STEEL CORPORATION SUBSIDIARY)

ENGINEERING NEWS-RECORD

NEWS

Volume 123 NOVEMBER 9, 1939 Number 19

$8,300,000 Contract Let for Air Base

The Arundel Corp. and the Consolidated Engineering Co., have been awarded a joint contract totaling $8,300,000 for construction of a navy air base at San Juan, Puerto Rico. The contract will be carried on a fixed fee basis. A breakwater estimated to cost $1,500,000 is the largest construction item.

• • •

Possum Kingdom Dam Gets RFC Loan

Completion of the Possum Kingdom Dam on the Brazos River in Texas was assured last week when RFC approved a loan of $4,200,000 to the Brazos River Conservation and Reclamation District. Of this sum, $2,458,000 will be used for electrical equipment and retirement of outstanding bonds. About $4,500,000 of WPA funds has been spent on Possum Kingdom Dam. The district had sought a PWA grant but this was prevented by the termination of the PWA program. The RFC loan will be repaid from power revenues and an annual state subsidy of $132,000. The Federal Power Commission held last week that the Brazos project is justified in the public interest because of its flood control and navigation features.

• • •

Lack of Engineers May Delay Indiana Work

Although the federal government has approved an Indiana state highway construction program involving the expenditure of nearly $5,000,000 next year, the limited number of engineers that can be employed under the present Indiana budget may delay the work, according to T. A. Dicus, chairman of the Indiana State Highway Commission.

Dicus explained that the present force is not sufficient to make the necessary surveys and to complete the required plans.

Wide World

INSTALLED AS PRESIDENT OF WORCESTER POLYTECHNIC

WAT TYLER CLUVERIUS, retired admiral of the U. S. Navy, has been installed as the seventh president of Worcester Polytechnic Institute. Cluverius is a graduate of U. S. Naval Academy, Annapolis, where he served for a time as head of the department of engineering.

Canada To Complete Atlantic-Pacific Highway

The Province of Ontario expects to start immediately on 112 miles of highway between Geraldton and Hearst in the Long Lac area north of Lake Superior to complete the first highway extending across Canada from the Atlantic to the Pacific Ocean. Work on the project is partially financed by the federal government but construction has been at a standstill for over a year.

The present plans have been drawn up in conjunction with the provincial department of highways, which estimates the cost of the work at $5,000,000. This winter, work in clearing the right-of-way, grading and ditching will be carried out.

Convict labor drawn from reformatories and prison farms will be used as much as possible.

Electrical Trades Indicted for Fraud

Federal grand jury charges Pittsburgh contractors, their association and labor leaders

Electrical contracting firms and individuals in Pittsburgh, their association and officials, and labor leaders felt the first blast of U. S. Deputy Attorney General Thurmand Arnold's investigation of the building industry when a federal grand jury in Pittsburgh on Nov. 3 handed down indictments charging conspiracy and collusion to defraud the government on PWA contracts in western Pennsylvania over the past three years. Named in the indictments were 43 individuals, thirteen electrical contractors and the Electrical Contractors Association of Pittsburgh. Included in the list of individuals were John Bradley, president, Michale P. Gordon, business agent, and Wm. G. Shord, secretary of A. F. of L. Local 55, Brotherhood of International Electrical Workers; also William F. Hess, president, and Robert C. Carmack, secretary of the electrical contractors association. Additional indictments were handed down on Nov. 6 charging 35 of the individuals with fraud in respect to signing statements to the effect no collusion had taken place in the preparation of bids. Special assistant U. S. Attorney General M. Neil Andrews, in charge of the investigation in Pittsburgh, has announced he will probe the heating, plumbing and ventilating contracting work this week.

The jury listed 84 projects in Allegheny County since January, 1935, in which federal money was involved as having a bearing on the conspiracy charges. Among the charges were that the individuals and firms named: "Did knowingly, wilfully and unlawfully and feloniously conspire, combine, confederate, agree and have a tacit understanding together and with each other and with divers other persons unknown to your grand jurors to defraud the

(*Continued on p.* 40)

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

AFTER GOING OVER the reports on investigations in more than a dozen cities Attorney General Frank Murphy says that "much of the high cost of construction is due to unlawful restraint of trade." Reports indicate, he states, that price fixing, control of channels of distribution, agreements as to markups, boycotts of certain manufacturers and distributors and bidding rings are some of the devices being used that restrict competition and enhance prices. Attorney General Murphy also made it clear that the department will not hesitate to take action against labor union practices which restrain trade. Action also is promised when jurisdictional disputes inflict unnecessary damage on the public. It is Murphy's announced intention to bring building prices into line with other prices.

HOUSE REPUBLICANS are planning to sponsor next session a low cost housing measure to be substituted for present legislation. Whereas funds are now obtained by sale of U. S. Housing Authority bonds and loaned by USHA to local housing authorities, the Republican proposal is for the local authorities to issue their own bonds, these to be federally guaranteed through the Federal Housing Administration. Chief effect of the change, which has not yet been put in the form of a bill, would appear to be transfer of administration of the housing program from USHA to FHA.

• • •

ELECTED PRESIDENT OF ENGINEERING TRUSTEES

HENRY A. LARDNER, vice-president of the J. G. White Engineering Corp., New York, has been elected president of the United Engineering Trustees. Founded in 1904 "to advance the engineering arts and sciences in all their branches, and to further research in science and engineering," the United Engineering Trustees is a joint agency of the four national societies of civil, mining and metallurgical, mechanical and electrical engineers. D. R. Yarnell, Philadelphia, is the retiring president.

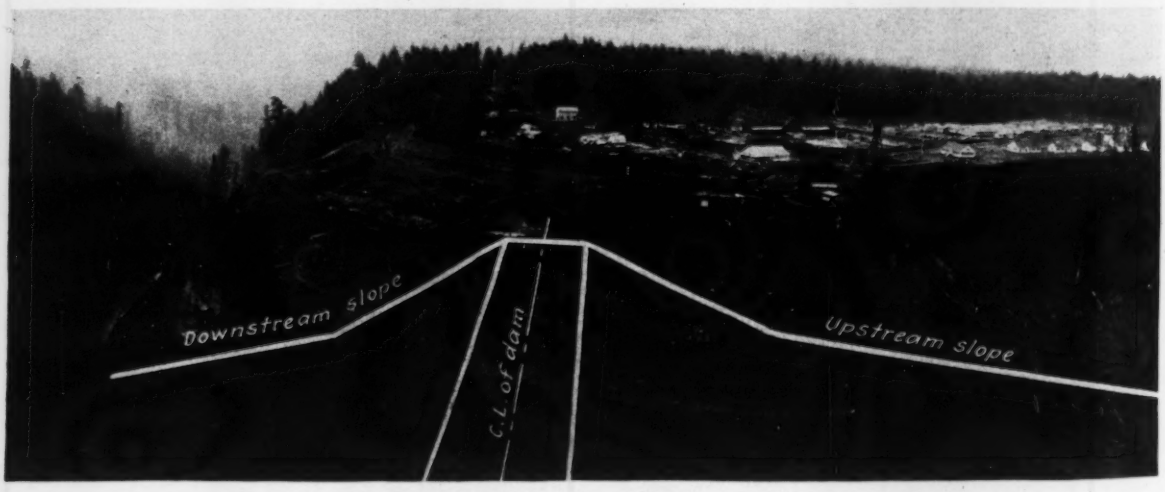
Seven Additional Schools Accredited by E.C.P.D.

Seven institutions have been added to the list of technical schools having courses accredited by Engineers' Council for Professional Development, according to a report made public recently. Additional courses have been okayed in six schools already having approved courses.

Engineering schools which have been added to the list include Alabama Polytechnic, Auburn, electrical and mechanical engineering; Northeastern University, Boston, civil, electrical, industrial, and mechanical engineering; Pratt Institute, Brooklyn, electrical and mechanical engineering; Southern Methodist University, Dallas, civil, electrical, and mechanical engineering; University of Tulsa, petroleum engineering; U. S. Coast Guard Academy, New London, Conn., general engineering.

Schools in which additional courses have been accredited are: Bucknell University, mechanical engineering; University of Illinois, railway civil engineering; railway electrical engineering and railway mechanical engineering; Massachusetts Institute of Technology, naval architecture and marine engineering; University of North Dakota, chemical engineering; University of Tennessee, chemical engineering; Louisiana State University, chemical engineering.

The headquarters of E.C.P.D. are established at 33 West 39th St., New York City.



CONSTRUCTION BEGINS FOR MUD MOUNTAIN DAM

CONSTRUCTION has started on the site of the Mud Mountain Dam, 47 miles southeast of Seattle, the dam to be built for the U. S. Engineers by the Guy F. Atkinson Co., San Francisco. In the upper left hand portion of the picture the contractor has begun the task of excavating 1,140,000 cu.yd. for the overflow spillway. Farther to the right is the contractor's camp in the center and at the extreme right is the engineers' camp. In the foreground a road is being built to reach to the upstream portal of the 23-ft. diversion tunnel.

Mud Mountain dam is to be a rolled earthfill structure 425 ft. high, 2,200 ft. from upstream to downstream toe and 54 ft. wide at the crest.

Hearings on Coulee Suit Begun in Washington

Hearings are now being held in the United States Court of Claims at Washington, D. C., in the suit brought by three contractors on Grand Coulee Dam asking $5,000,000 extra performance claims. The three plaintiffs—Silas Mason Co., Inc., New York City; Walsh Construction Co., Davenport, Iowa; Atkinson-Kier Co., San Francisco—have stated 32 causes of action to show why they should be paid $5,000,000 extra for the work done in the $40,000,000 low dam work at Grand Coulee.

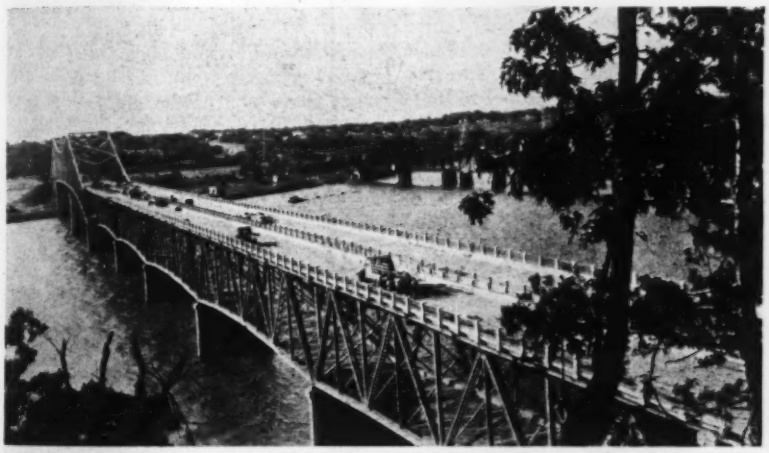
The major question at issue centers on whether the government failed to fulfill some of its contract obligations and whether or not the government refused to compensate for extra work resulting from changes in the contract requirements. Court decision hinges upon the arbitration clause of the contract which reads as follows: "Except as otherwise specifically provided in this contract, all other disputes concerning questions arising under this contract shall be decided by the contracting officer or his duly authorized representative, subject to written appeal by the contractor within 30 days to the head of the department concerned or his duly authorized representative, whose decision shall be final and conclusive upon the parties thereto as to such questions. In the meantime the contractor shall diligently proceed with the work as directed."

The contractors did not make use of the arbitration provision because they held that it illegally deprived them of the right of arbitration through a disinterested party such as a court of law.

• • •

Bids for Fern Ridge Dam To Be Opened in February

Bids will be opened about Feb. 1, 1940, for Fern Ridge Dam, a structure to be built by the U. S. Engineers, 12 miles northwest of Eugene, Ore. The work is estimated to cost $2,000,000 and is designed for flood control and regulation of the Willamette River.



TOLL BRIDGE SPANNING TENNESSEE RIVER COMPLETED

A HIGHWAY BRIDGE providing two 20-ft. lanes, separated by a 4-ft. sidwalk, has been completed and placed in service across the Tennessee River between Florence and Sheffield, Ala. Overall length of the bridge project is 1.9 miles. The work was done by the Alabama State Highway Department at a cost of $1,150,000. The bridge consists of three 36-ft. concrete spans, five 190-ft. deck steel trusses, a 240- 420- 240-ft. continuous steel truss and three 30-ft. concrete spans.

The work was financed by the Alabama Bridge Commission, an agency of the State of Alabama. The commission turned the money obtained from the sale of bonds over to the state highway department, which matched federal aid money provided by the PRA. The bridge will be operated by the bridge commission until the tolls retire the bonded indebtedness and then the structure will become a free bridge and the property of the highway department.

The bridge was designed by the highway department, Chris J. Sherlock, director; J. B. Trotter, bridge engineer, and G. P. Willoughby, project engineer. M. C. Giles is secretary of the Alabama Bridge Commission. The Hardaway Contracting Co., Columbus, Ga., was the contractor for the substructure, and the Virginia Bridge Co., Roanoke, Va., did the steel superstructure work. The roadway approach grading was done by the Hooper Construction Co., Jacksonville, Fla.; construction of the concrete floor of the bridge by the Rust Engineering Co., Birmingham, Ala., and the approach paving by Warren Bros. Roads Co., Boston.

Quebec Construction Affected by Election

Road building and unemployment work stopped. Contracts cancelled for public works projects

Several million dollars of road construction in progress in the Province of Quebec and all unemployment projects in the Montreal district administered by the provincial Economic Reconstruction Bureau were shut down recently because of the results of the provincial election. All contracts let by the provincial Department of Public Works, with the exception of half a dozen urgent jobs, also were cancelled.

In the election, which attracted international attention because it involved the federal government, the Duplessis administration was defeated and the Liberal party returned to power in the provincial legislature.

Much of the road work initiated by the Duplessis government has been subjected to extreme criticism, notably the new entrance road to the city of Montreal from the west. Work had just been started on this project when the order was received to stop work.

Anatole Carignan was not re-elected as Minister of Highways.

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Returning Engineers Bring Canal Data

Brig-Gen. Clarence S. Ridley, Governor of the Canal Zone, has come to Washington in connection with a proposed Congressional appropriation for building new locks to double the capacity of the Panama Canal.

Another group, the Nicaraguan Canal Commission, also is back in the United States. This group, which was sent to Central America by the United States government to make a survey of possibilities of a barge canal along part of the route of the projected Nicaraguan Canal, includes Lieut. Col. C. P. Gross, Lieut. Col. Paul N. Hawley, Captain Leslie R. Groves and Captain Thomas H. Stanley, Carter Page and E. E. Abbott.

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$50,000,000 Housing Loan Released for Sale

Eleven local low-rental public housing authorities on Nov. 8 released $50,000,000 issue loan notes. The notes, offered to private investors, were drawn up under the plan for short-term financing described in *ENR* Nov. 2, 1939, p. 587.

FPC Finds Brazos Project Justified Improvement

Construction of the Brazos River project in Texas is "desirable and justified in public interest for improvement of Brazos River for commerce" according to a finding recently filed by the Federal Power Commission. In the opinion of the commission, the operation of the project will have the direct effect of increasing the flow during low water periods, with consequent increase in navigable depths, in and along the Brazos River below the project.

It is believed that the operation of the project will reduce flood flows, with consequent reduction of bank caving, siltation of channels, damage to wharves and docks, and channel shifting. The project consists of a concrete dam 1,653 ft. long with an earth dike 960 ft. long, and a power house to contain an installation of three 10,000 kw. units.

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Minnesota Grand Jury Indicts Road Men

Indictments have been returned by the Ramsey County grand jury in Minnesota in the case of a highway department employee and contractors said to be involved in a case of enforced payment to political campaign funds.

Charges of violation of the state's corrupt practices act placed against the contractors climax a dispute between the county attorney and the legislative committee investigating the case. The committee chairman claimed the payments were "bribes," and that the contractors concerned were entitled to immunity. The county attorney felt that action should be taken under the corrupt practices statute under which the donor is considered equally guilty with the recipient. Eleven contractors were originally named in the investigation. No-bills were voted by the grand jury in four cases.

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Golden Gate Traffic Gains 22 per Cent

A traffic increase of 22 per cent in the number of vehicles crossing the Golden Gate Bridge is reported by the Golden Gate Bridge and Highway District for the year ending June 30, 1939, compared with the preceding year, which was the first full year of operation. The traffic figures are 4,031,504 against 3,311,512. Important items in the increase were commutation automobiles, which increased 153 per cent, and trucks, which increased 70 per cent (from 164,224 to 279,054). Part of the traffic growth resulted from shutting down the ferry service of the Southern Pacific Golden Gate Ferries, Ltd., from Hyde St., San Francisco, to Sausalito, which took place late in July, 1938.

Bridge revenues showed an increase of 19 per cent, to $1,910,820, which was $311,133 over the preceding year, but below the total of expenditures by $135,003. Interest charges amounted to $1,519,500, operating expenses $276,253, and repairs and depreciation $250,069. Bond retirement does not begin until 1942.

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Viaduct Maintenance Cost To Be Tested in Omaha

The Omaha city council has begun action which may settle the question of whether railroads can continue to be held financially responsible for construction and upkeep of street viaducts across railroad yards and tracks within the city limits.

The railroads have been compelled by city law for years to build and maintain the existing structures. Now the railroads maintain that the United States Supreme Court decisions render such city legislation invalid. The railroads argue that it is improper to force one type of business to spend its money for the benefit of a competing class of business. The city has begun proceedings to require various railroads to modernize and repair three viaducts. Meanwhile, the Northwestern Railroad has a suit in federal court to enjoin the city from making it rebuild and widen one of its overpasses in the city.

Pittsburgh Inquiry

(*Continued from p. 37*)

United States. . . . That while keeping up an appearance of competition and conveying to awarding authorities the idea and belief that said defendant electrical contractors were rival bidders, the defendants agreed that they would abate honest rivalry, avoid and prevent competition, deceive the awarding authorities, prevent transmission to awarding authorities of bids, and, in effect, secure in advance to awarding of contracts to one of the defendant electrical contractors selected by them, and so cheat the plain intent and purpose of said acts and resolutions and defraud the United States, all to the mutual profit of the defendants, the injury and damage of the United States, the selfish destruction of the public interest and the impairment of government functions and the discredit of public officials."

The indictments further charged that contractors would submit bids in advance to the secretary of their association, and the firm bidding the nearest to the average of all bids would be designated to submit his figure as low to the awarding authority. Other firms, it was charged, would adjust their figures above that of the designated low bidder. Furthermore, it was alleged that the association and labor officials, by intimidation, by bribes and threat of strikes, by calling of strikes and by threats of present and future injury to business, would prevent nonmembers of the association bidding.

Bonds ranging from $2,500 to $5,000 have been required of all defendants.

Sovfoto

TRACK-LAYING MACHINE USED BY RUSSIAN ENGINEERS

An unusual track-laying machine is being used in Russia in the construction of new railways. Whole sections of track the length of a standard rail are carried on the pioneer car and are swung into place by a crane. As soon as each section has been bolted into place the machine moves forward and the next section is placed. Surfacing is done behind the tracklayer.

Griffith Low Bidder On Aquaduct Filters

Griffith Co. of Los Angeles has been named low bidder with its bid of $1,630,000 for the construction of a water softening and filtration plant to be built as a part of the Metropolitan Aqueduct work in Southern California, according to F. E. Weymouth, general manager of the Metropolitan Water District. To be located near LaVerne on the upper feeder of the distribution system, the plant will soften and filter all Colorado River water to be used for domestic and industrial purposes in Los Angeles and the twelve other cities comprising the district.

Eight bids for the construction of the plant were received by the district, and the George A. Fuller Co., Los Angeles, was second low bidder with its bid of $1,634,000. First deliveries of the water are expected to begin in about a year.

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Pennsylvania Factory Work Totals $36,000,000

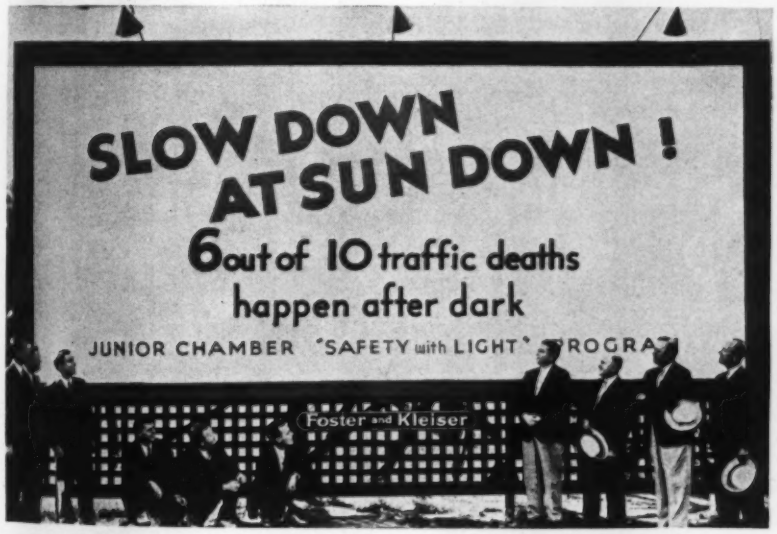
During the first six months of this year $36,000,000 worth of industrial construction was started in Pennsylvania, according to Richard P. Brown, state secretary of commerce. Brown predicts that by the end of this year the total for new industrial construction, plus new utility construction to take care of the increased industrial load, will have reached $100,000,000.

PWA Director Reports On Connecticut Inquiry

Reporting for PWA on the investigation ordered by Governor Baldwin of Connecticut to determine whether there had been any irregularities (*ENR* Oct. 19, p. 507), M. E. Gilmore, regional PWA director, states that the reason certain Connecticut towns profited from dual grants for financing road projects was the method in distributing state-aid money. He further indicated that this condition was noticed three years ago, namely, that state-aid funds for road construction were in excess of the amount required to pay the local share of the cost. The matter was taken up by PWA, and it was found that under the contract between the government and these towns, the town had earned the full amount of the grant set forth in the offer. On this basis PWA granted the full amount earned.

It was also noted that in many cases an agreement existed between state and town. For instance, the town would turn over to the proper state account all federal funds earned. However, since the payments of the final check ended the PWA participation, and since any agreement between state and its subdivisions was outside jurisdiction of PWA, no attempt was made to police the payment of such funds after PWA participation had ended.

State highway officials contended that the profits to various Connecticut towns resulted from PWA grants.


SLOW DOWN
AT SUN DOWN !
6 out of 10 traffic deaths
happen after dark
JUNIOR CHAMBER "SAFETY with LIGHT" PROGRA
Foster and Kleiser

LONG BEACH WINS "SAFETY WITH LIGHT" AWARD

In a campaign that won first place in the 1939 "Safety with Light" program, sponsored by the U. S. Junior Chamber of Commerce, members of the Long Beach, Calif., chamber erected billboards similar to the above.

A survey showed that 50.8 per cent of the night accidents, which had been costing Long Beach $9,875,000 yearly, occurred mainly on nine thoroughfares representing but 11.2 per cent of the total city street mileage. The accident frequency on those streets has declined since the campaign began.

Engineers Discuss Highway Economics

New York meeting centers around a paper prepared for the cancelled international conference

Economic questions affecting highway development were the subject of extensive discussion at a joint meeting of metropolitan sections of the American Society of Civil Engineers and the American Society of Mechanical Engineers held in New York on Oct. 31. Discussion centered around a paper entitled "Problems of the Highway User in the United States" prepared by F. C. Horner, assistant to the chairman, General Motors Corp., for presentation at the British-American Engineering Conference that was cancelled on account of the outbreak of war in Europe. Other speakers included Thomas H. MacDonald, commissioner, Public Roads Administration, Chester H. Gray, director, National Highway Users Conference, Harold M. Lewis, chief engineer, Regional Plan Association, Wm. G. Grove, Connecticut highway department, H. S. Fairbank, U. S. Public Roads Administration, and W. C. Huebner, Association of American Railroads.

Horner centered his remarks on the importance of developing our highways as a means for providing the best possible transportation at the lowest cost. He voiced opposition to any regulation or rate control that would tend to freeze rates or would hamper highway transport just to give railroads an artificial competitive advantage.

Turning to the question of toll roads, Horner characterized the recent Public Roads Administration report on "Toll Roads and Free Roads" as a monument to sound thinking on highway costs. Later in the evening an illustrated summary of that report was given by H. S. Fairbank.

Harold M. Lewis emphasized the need for regulation to protect the carrying capacity of main highways. Lewis favors the development of freeways, but pointed out that unless the right to acquire and sell excess land for superhighways, as proposed in the PRA report, is supplemented by power to limit access to those highways the resale provisions will serve chiefly to clutter up the highway with roadside stands.

Gray spoke against unlimited extension of the toll road idea, although he recognized that it may serve a useful purpose in some instances. He noted the rising trend in right-of-way costs and said that if it is not checked such costs may soon exceed the cost of the road itself.

Grove reviewed why Connecticut had placed tolls on the Merritt Highway.

OBITUARY

BENJAMIN R. MESEROLE, 79, former head of the Messerole City Surveying Co., Brooklyn, N. Y., died Nov. 5 in Bellport, L. I., N. Y. From 1882 to 1901 Meserole was city surveyor for Brooklyn and from 1901 to 1907 city surveyor for Greater New York.

W. FRED STARKS, 64, former Nassau County, N. Y., engineer and superintendent of highways, died Nov. 1, from injuries received in an auto accident. Starks retired in 1936 after 21 years as Nassau County engineer.

NOBLE FOSTER HOGGSON, president of Hoggson Brothers, New York City contractors specializing in bank buildings, died Oct. 25 at the age of 74. Hoggson received his engineering education at Sheffield Scientific School, Yale University. He organized Hoggson Brothers in 1897 and had been president of the company since 1916.

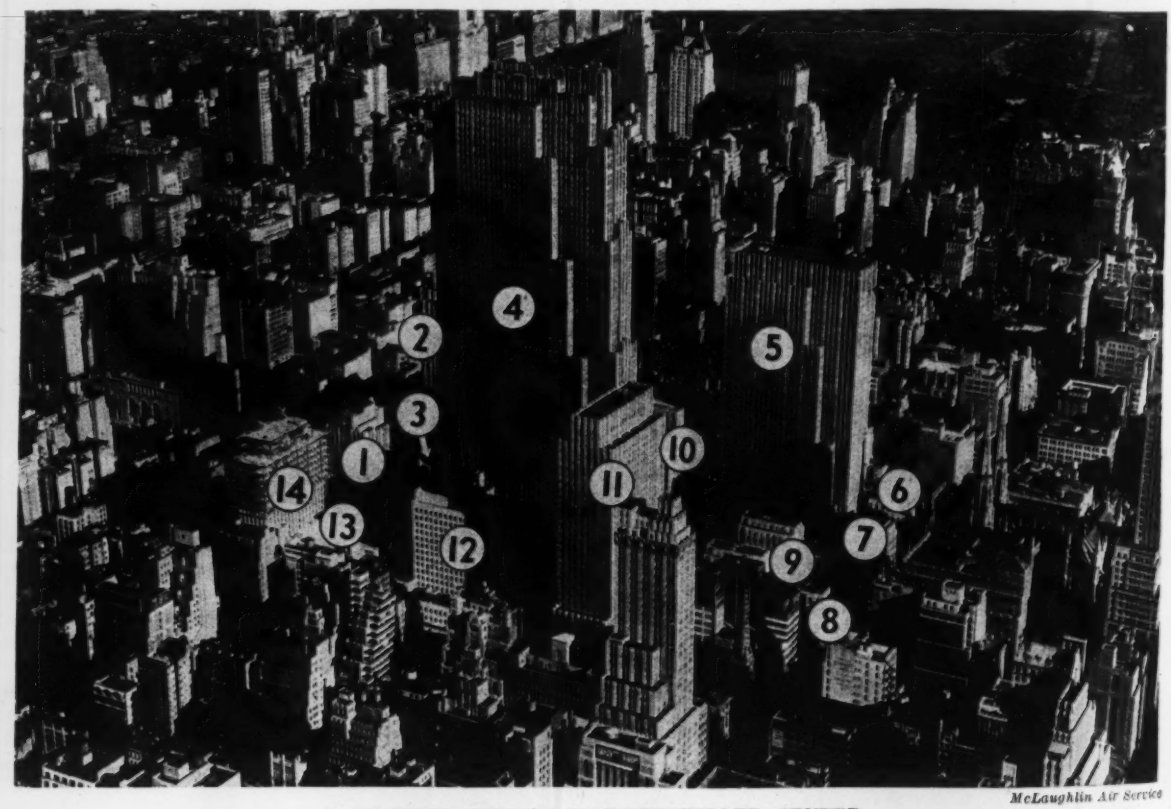
GEORGE B. AVERY, 74, contractor, died recently in Seattle, Wash. Avery served for a time as assistant supervisor of the State of Washington department of labor and industries, and later was superintendent of public utilities for the city of Seattle.

THOMAS MARTIN, retired division engineer of the Canadian Pacific Ry., died recently in Winnipeg, Man. Martin served as resident engineer at Cranbrook, B. C., for a time and later was division engineer at Calgary and Moose Jaw. He also was engineer of the Portage Division for a time.

EARL IRWIN, 52, civil engineer, died recently in Toronto, Ont. Irwin had worked with the Canadian Pacific Ry. and the Russell Construction Co. of Toronto.

DAVID W. BURPEE, civil engineer of Fredericton, N. B., died recently in that city at the age of 64. From 1917 to 1925 he worked at Fredericton, N. B., as district highway engineer for the provincial public works department. The next few years were spent with the engineering staff of the Canada Steamship Co., Montreal. Ill health made his retirement necessary in 1927.

Other recent deaths include: THOMAS A. NICHOLSON, 71, canal and railway contractor, in St. Catharines, Ont.; A. H. BARKER, 68, builder, Phoenix, Ariz.; JAMES WICKERSHAM, 82, builder, Juneau, Alaska; PIERRE PAQUETTE, 85, head of Paquette & Godbout Co., St. Hyacinthe, Que.; ARTHUR A. KING, 52, planning and construction engineer, Congress Junction, Ariz.; FOSTER F. NALTHING, 52, consulting engineer, Glen Cove, L. I., N. Y.; FREDERICK G. JOHNSON, 86, builder, Ottawa, Ont.; DAVID CONROY, 100, building contractor, Edmonton, Alta.; LEONARD OBERG, 75, building contractor, Omaha, Nebr.; S. PORTER BROWN, 57, manager of the George A. Fuller Co., Boston, in Boston; ROBERT S. SMITH, 64, contractor, Seattle, Wash., and BENJAMIN ROSS, contractor, Seattle, Wash.



McLaughlin Air Service

LAST RIVET DRIVEN IN ROCKEFELLER CENTER

SIGNALIZING the completion of nearly a decade of work, the last rivet was driven Nov. 1 in the fourteenth and last building of New York's Rockefeller Center. John D. Rockefeller, Jr., wielded the rivet hammer. The building is No. 1230 Sixth Ave. (No. 14 in the above illustration).

Major development work on the 12-acre site began in 1931, and more than $100,000,000 has been invested.

The aerial photograph above shows the various structures as follows: (1) RCA Building West; (2) RKO building, behind which is hidden; (3) Radio City Music Hall; (4) RCA Building; (5) International Building; (6) International Building East; (7) Palazzo d'Italia; (8) La Maison Française; (9) British Empire Building; (10) Associated Press Building; (11) Time and Life Building; (12) 10 Rockefeller Plaza; (13) Center Theatre; (14) 1230 Sixth Avenue, now being completed.

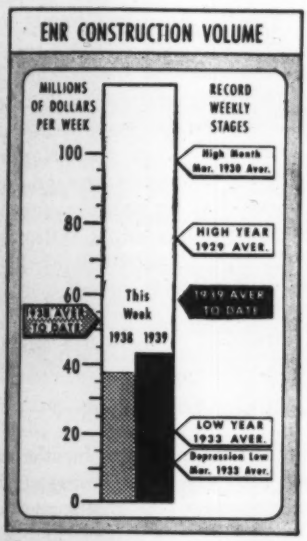
Sewage Disposal Costs Being Investigated

Niagara Falls, N. Y.'s sewage plant, which has run a thorny course until its 1939 completion and acceptance by the city, again has broken into print with the report that an extraordinary county grand jury will sift rumors of corruption in the letting of contracts and that city officials solicited campaign funds from bidders on contracts. The inquisitorial body also is reported as bent on looking into a report that the sanitation plant actually cost more than was budgeted for the purpose, and that old equipment was installed and represented to the city as new.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the short week due to the Election Day holiday total $53,603,000, a 44 per cent gain over the corresponding week in 1938.

The current week's awards bring the 1939 total to date to $2,613,957,000, an increase of 11 per cent over the $2,343,931,000 reported for the initial 45-week period last year.



Private construction for the week is 285 per cent higher than in the week a year ago, due to the increased volume of industrial and commercial buildings. This is the ninth consecutive week that private awards have topped their respective 1938 values. Public construction is 7 per cent above a year ago.

In the classified construction groups, gains over the week last year are in waterworks, sewerage, industrial buildings, commercial building and large-scale private housing, earthwork and drainage, streets and roads, and unclassified. Increases over the preceding week are in waterworks, sewerage, bridges, industrial buildings, and streets and roads.

New capital for construction purposes for the week totals $12,225,000, a decrease of 85 per cent from the volume for the corresponding week last year. The current week's financing is made up of $4,850,000 in corporate security issues, $4,121,000 in state and municipal bonds, and $3,254,000 in RFC loans for public improvements.

New construction financing for the year to date, $2,263,267,000, is 35 per cent lower than the $3,491,107,000 reported for the 45-week period last year.

(*Weekly Contract Table on page* 35)

Work Continues On Mexican Railways

Economic difficulties and European war fail to halt work on four trunk lines.

Despite the economic depression and difficulties in obtaining materials and equipment because of the European war, the Mexican federal government is going ahead with the construction of four trunk railroads started in 1936 to open up rich agricultural and mining regions in various parts of Mexico. This is the greatest railroad construction program ever undertaken by the Mexican government and is being done almost entirely without financial or technical aid from foreigners.

A combined length of 960 miles is being built at a cost of about $31,000,000 and efforts are being made to have the work completed by the end of next year.

The four principal lines are: (1) The southeastern, which will be 450 mi. long to connect Mexico City with the isolated areas in the states of Campeche and Yucatan; (2) The 220 miles of line between Ixcaquixtla, in the state of Puebla, and Chacahua Bay on the Pacific; (3) The northwest line, 100 miles in length joining Fuentes Brotantes, in the center of Lower California, and Punta Penasco, a port on the Gulf of California, and (4) A line joining Caltzonzin, Michoacan State, and Central Mexico.

A branch line 60 miles long is to be built between Punta Penasco and Sonoyta in Sonora. This work will cost $830,000.

It has not yet been decided whether the government will directly operate these railroads or lease them to private enterprises.

ENGINEERING CONSTRUCTION CONTRACTS REPORTED BY ENGINEERING NEWS-RECORD, IN OCTOBER, 1939

Engineering News-Record *reports projects of the following minimum costs: — water-works, excavation, drainage and irrigation,* $15,000; *other public works,* $25,000; *industrial buildings,* $40,000; *other buildings,* $150,000

Four Weeks — Thousands of Dollars (000 Omitted)

Public Works	New England	Middle Atlantic	South	Mid West	West Mississippi	Far West	United States Oct. 1939	United States Ten Months 1939	United States Ten Months 1938	Canada
Waterworks	93	444	270	88	2,581	544	**4,020**	147,486	94,193	180
Sewerage	164	2,184	729	1,497	3,836	5,139	**13,549**	140,939	96,168	464
Bridges, public	302	2,275	623	1,078	925	548	**5,751**	123,755	88,500	243
Earthwork and waterways	302	8,314	11,878	768	3,262	10,583	**35,107**	204,097	232,755	591
Streets and roads	1,604	13,005	3,360	6,121	12,008	5,237	**41,335**	534,519	536,357	1,118
Buildings, public	915	8,418	12,202	2,321	3,092	1,312	**28,260**	497,604	334,845	342
Unclassified, public	51	3,678	1,511	430	1,558	2,085	**9,313**	144,381	157,499	833
Total public	**3,431**	**38,318**	**30,573**	**12,303**	**27,262**	**25,448**	**137,335**	**1,792,781**	**1,540,317**	**3,771**
Federal government (included in above classifications)	211	10,055	15,300	1,526	4,534	13,271	**44,897**	296,684	298,310	.....
Private										
Bridges, private	60	280	.....	160	775	.....	**1,275**	6,513	5,551	130
Buildings, industrial	2,690	21,221	8,110	9,351	5,090	3,448	**49,910**	220,820	128,556	2,518
Buildings, commercial	2,965	8,525	2,170	5,773	2,423	10,780	**32,636**	310,168	486,371	1,475
Unclassified, private	90	2,591	4,072	6,295	8,453	2,405	**23,906**	180,032	74,863	269
Total private	**5,805**	**32,617**	**14,352**	**21,579**	**16,741**	**16,633**	**107,727**	**717,533**	**695,341**	**4,392**
Total Engineering Construction										
October, 1939 (4 weeks)	**9,236**	**70,935**	**44,925**	**33,882**	**44,003**	**42,031**	**245,062**	.....	.....	**8,163**
September, 1939 (4 weeks)	19,715	59,476	23,712	47,277	41,875	17,282	**209,337**	.....	.....	12,002
October, 1938 (4 weeks)	16,819	82,104	28,348	32,150	45,646	30,831	**235,898**	.....	.....	10,161
Ten Months — 1939	134,995	805,426	375,602	470,859	457,071	266,361	.....	2,510,314	.....	**99,834**
Ten Months — 1938	112,077	872,978	222,237	297,059	387,239	344,068	.....	.....	2,235,658	**73,640**

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Soil Shear Dynamometer

Sir: One point mentioned in the article "A Soil Shear Dynamometer" (*ENR*, Oct. 12, p. 478) has been noted which may prove misleading. The spring dynamometer described by Prof. C. R. Young is a good device for apparatus requiring a moderately priced load measuring device. However, the suggestion of using it in place of a proving ring in a soil shearing machine of the M.I.T. type is not sound. Although it may be as good as the ring for accuracy, it does not meet the requirement of negligible compressibility.

Due to the construction of our machine, any appreciable compression of the load measuring device causes a tilting of the vertical yoke and the upper frame of the shear box, thereby introducing a shearing component along with the vertical load. A water filled bellows which compressed as much as ½ in. was the original scheme on the M.I.T. machine, but this had to be discarded because of its high compressibility. It appears that the total compression of Professor Young's dynamometer is in the order of 1 in.

Our heavy proving ring reading within 1 lb. over a range of 1,000 lb. has a maximum deflection of .02 in., and the light ring reading within 1/10 lb. over a range of 200 lb. has a maximum compression of .04 in.

HAROLD A. FIDLER
Instructor in Civil Engineering, Massachusetts Institute of Technology

Sir: While it is true that a considerable compressive deformation at high loads occurs in the soil shear dynamometer described in *Engineering News-Record* of Oct. 12, the instrument may be used in such a manner as to reduce errors due to the inclination of the vertical yoke to amounts that are negligible in practical soils work. This involves setting the yoke off the plumb at the beginning of the test by an amount equal to the estimated final inclination and opposite in sense to it.

In the use of the device for an extensive series of recently conducted shear tests on soils for an earth dam it was found that in the average case the horizontal component of the pull in the yoke was not over 2 per cent of the vertical component. The shear resistance read on the dynamometer would therefore be about 2 per cent of the vertical load too high at the beginning of test and 2 per cent of the vertical load too low at the end of it.

For purposes of precise research, a device with less compressibility, such as that described by Mr. Fidler, would be desirable. On the other hand, regard must always be had to the fact that the irregularities and variables associated with the selection, taking, cutting, trimming and placing of soil samples make any high degree of accuracy wholly illusory.

C. R. YOUNG
Professor of Civil Engineering University of Toronto

Publicity for Engineers

Sir: J. A. Varela's contention in *Engineering News-Record* of Oct. 12, p. 456, that more engineers would be famous today if greater recognition were given to engineers at ceremonies and in the press will probably be agreed to by most engineers.

It is also regrettable that it is not easy to ascertain the engineers responsible for every good work. It would be very helpful if the American Society of Civil Engineers would adopt a standard for a memorial to the engineers of every work of importance. For example, on smaller bridges and dams the name of the chief engineer should appear; on bridges and dams of large size, the names of the principal engineers should be permanently inscribed on a suitable plaque. If a dignified standard in detail were adopted, it would probably meet with general and willing acceptance.

Another suggestion is that engineering societies should more frankly cultivate a spirit of appreciation. What we would like is to be proud that we are engineers. It is regrettable that we feel that way only at the death or retirement of some brother engineer. We feel elation rather than uplift when we win a medal or some competition. Depreciation is often the bitter lot of a brilliant worker. Pride in the profession comes from being able to give recognition gladly and warmly. A generous appreciation is a necessary ingredient in an honest fellowship. Lacking that, we hold the profession cheaply and are in turn so valued.

EDWARD M. CRAIG, JR.
Assistant Engineer Board of Water Supply, New York City Neversink, N. Y.

Rugged Transits

Sir: In *Engineering News-Record* Oct. 12, 1939, L. Mead Hammond expresses *much mental anguish* about the portrait of James Brindley, engineer, shown on page 67 your issue of Aug. 17, 1939.

The *flimsy soft brass instrument* which is shown would show definite deflection if a mere 5-lb. weight were attached, and the accuracy of the work in those days was lacking. Today we construct transits that bear up under terrific loads—1,442 lb. or more by actual test. However, even today this great strength does not mean that an engineer supports himself by leaning on the instrument.

I am sure the artist is wholly to blame in your old portrait.

L. F. BUFF
President, Buff and Buff Mfg. Co., Boston, Mass.

Two-Fisted Engineers

Sir: As an observer for the past thirty-five years may I suggest that the answer to Mr. Gannett's question, "Why So Few Famous Engineers Today?" (*ENR*, Aug. 17, p. 227) is found, in part, in the fact that too many engineers have degenerated into civil-serviced, mechanical-brained robots who have lost all or most of the human attributes, soulless, self-centered, ignorant of life outside their craft, ciphers with the rim erased.

They were not like that when this writer was "pigtail" flagman. Then the chief might in a single hour check a material list; order a carload of steel; give his wife a couple of bucks for groceries; slip the kid two bits for the matinee; put a not-too-platonic arm around the stenographer; walk across the street to catch two cronies going into the corner bar; and finish out the hour singing baritone to that old favorite

about the two grasshoppers that sat upon two other grasshoppers' necks. And when he strolled home men crossed the street to greet him with a cheery hello instead of ducking into a doorway.

Mr. Gannett drew attention to the fact that there are perhaps thousands of engineers in private practice who are not projecting their heads above the horizon. Let me add that there are even more thousands of equally or more competent engineers who are barred from practice because of registration requirements which the lobbyists claimed would do so much for the profession. Ye Gods! what have we done? First, politically well organized home-guards pass laws prohibiting rolling-stones with greater experience and broader training from competing with them, and then, after the laws have been in effect a few years, they who gained registration simply because they were nominally engaged in engineering practice when the law took effect, are bewildered at learning the law failed to make engineers out of them as well as giving them the legal standing.

At the time the engineers Mr. Gannett mentions were developing this country was undergoing a great expansion over a considerable area. The demand for engineers was filled by grabbing every man who could do a good job, regardless of his collegiate training, his long-term residence. That man did his work one way or another. He built the railroads, the super-bridges of his day, irrigation systems, and our cities. His work became popular. Colleges with an urge to keep their classrooms filled with paying customers overemphasized the value of mathematics as a substitute for training on the job. To support their propaganda their laboratories developed intricate routines instead of trying to simplify them. They fostered the creed whereby college men in influential positions should hire only college men. By a natural process of selection the engineer went through a process of evolution which changed him from a man who, seeing a job to do, went ahead and did it into one who, seeing a job to do, sits down and draws diagrams for the man who eventually does the work.

Having seen that the methods of development of the past few decades will produce, not engineers, but only mathematical acrobats, it would seem that, wanting engineers, Mr. Gannett should look to the men who have made it a practice to go from one job to another without examination ratings or the assistance of friends. There, among the younger men, will be found those who have the spirit for which he searches.

But that spirit can find no expression as an engineer except through the medium of some registered nincompoop who frequently is unable to plumb a rod. The true pioneer, finding himself barred from his life work by political and graduate preferment, goes from his employment with the lead-pencil wizards to running cats, bulldozers, cranes and other implements of the craft to which he instinctively belongs.

To produce the engineer in the model of those who stood out from the crowd of gristmill chaff, first remove the restrictions such as examinations which only a collegian or a grind can pass, the residential requirements and the graduate preferment, making the job-record more important as it should be. Then take a young man who wants to build something. Advise him not to spend more than a year or so on a single job, on one type of engineering, or in one town. He should occasionally take a vacation which will take him away from the great domeheads and allow him to renew his acquaintance with section hands, carpenters, and even bartenders. Above all else he should forget the silly twaddle about engineering not being a trade but rather "a wholesome service, unselfishly given to humanity and in which financial returns are no incentive, accomplishment being the motivating desire." He should take a pride in his vocation, whether he calls it a trade or a profession, but his greater pride should be the doing of a job, well done and amply rewarded. He probably must throw a little bull now and then but in general, he will get farther ahead if when the bull-sessions are on he, instead of listening, slips downtown where he can drink a little three-two and play rummy with the shovel-stiff, the cat-skinner, and the donkeyman.

Then perhaps in a few years the engineer may again develop into a mortal loved by his wife and welcome among friends. A fair percentage of such men will rank with Eads, Roebling, and the other standouts. Great men have never been turned out by mass-production but are rather the product of free, untrammelled development. And perhaps men who do things may again proclaim, "We are the R.A.E., we live in caves and ditches. We knock our socks against the rocks, us hardy sons of guns."

Now, in semi-retirement, I regret I shall not see that day.

H. C. SAWYER
Lakeport, Calif.

Three-Point Problem

Sir: The plane table solution of the 3-point problem proposed by L. W. Jones and B. W. Basten (*ENR*, Oct. 12, 1939, p. 488) appears to have some merit. To avoid misuse of the method, however, it should be understood that the method is not "exact", as the authors claim. The loci of the vertices of the triangles of error, which have been assumed to be straight lines, are actually the arcs of circles which pass through *a* and *b*, *b* and *c*, or *c* and *a*. Thus in Fig. 2 the required point is a little to the right of *d*, and in Fig. 3 is a little to the left. If the triangles of error are small and close together, this error might very well be negligible.

It may be of interest to note that these circles could easily be constructed from a single set of observations, if the surveyor's equipment happened to include a compass. This construction has been mentioned by Breed and Hosmer, in *Principles and Practice of Surveying, Vol. II*, page 205.

DAVID B. HALL
Haworth, N. J.

Sir: The paper by Lynn W. Jones and Burton W. Basten, *Engineering News-Record*, Oct. 12; outlines the method which Jordan in his "Handbuch der Vermessungskunde" prefers to the Lehmann method. It is interesting that the Jordan method has not been offered in any of our texts. Jordan prefers the tracing cloth method first and the method described by Jones and Basten next.

The illustrations used by Jordan are very similar to those used in the article. He does not mention the device used by Jones and Basten for saving the flagman's steps. This method should be very helpful in the triangle of error method.

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NOVEMBER 9, 1939

THAT ESSENTIAL of the engineer's equipment, imagination, came to the aid of the engineers engaged in a small highway bridge replacement described in this issue. Quite undismayed by the topographical obstacles to a temporary detour crossing they built one in concrete, made it good enough for permanent use and then, when the setting was ready, shoved it over to replace the old bridge. This was one detour on which the motorists didn't grumble!

Waterworks Growth

SIGNIFICANT CHANGES in waterworks developments are portrayed by M. N. Baker (p. 53) who looks at the scene from the vantage point of half a century of experience. Perhaps the most interesting observation is the growth of municipal waterworks facilities from 1,878 in 1890 to 12,760 plants today. Improved water quality, says Mr. Baker, has played the major role in the reduction of typhoid death rates from the astounding heights they once attained. Ownership of systems has likewise undergone a significant change—today 73 per cent of the facilities are publicly owned as contrasted with 43 per cent in 1890. These changes in growth and ownership are indicative of the high value which communities place upon their most essential public utility.

A New Paving Idea

THE EXPERIMENT of putting concrete pavement slabs under endwise compression described on a following page brings a new line of thinking into roadbuilding. Briefly the thought is that if the pavement is not only restrained from movement during the curing period but is also subjected to a positive counteracting pressure, tension or shrinkage cracking will be impossible. What the results will be on the Missouri test road must await the maturing of the experiment and this is being zealously watched. Whatever the outcome is, credit can be given to the engineers for devising a most simple solution to what at first sight seems the rather formidable physical problem of putting cumulative endwise pressure on paving slabs during normal construction procedure in concrete road-building.

Precedent Set

THE BLAST that broke down the final barrier between Manhattan and Queens headings of the East River tunnel at New York a few days ago marked a milestone in tunnel history. Safety, speed and efficiency were carried up to new levels in the East River enterprise, as difficult and dangerous a subaqueous tunnel as ever was attempted. Other 30-ft. tunnels have been built through rock and plastic silt, but none had to penetrate many hundreds of feet of mud, sand, riprap and decayed rock. Regardless of such difficulties the face was never lost, except on the one occasion of a heading fire. And not a single life was lost from bends. As for speed, the contractor is months ahead of a schedule that had been placed near the minimum believed possible. His efficiency also kept down the cost and promises to save more than a million dollars. The East River tunnel is an achievement in which both the engineering organization, under Ole Singstad, and the contractor's organization, under Jack McDonald, may take pride as setting a high mark for future under-river tunnel driving to shoot at.

Fatigue Strength of Welds

REASSURING RESULTS respecting the strength of welded joints under repeated stresses were obtained in a test program at the University of Illinois reported to the American Welding Society by Prof. Wilbur M. Wilson. More specifically, they are reassuring if previous results for riveted joints, which showed a fatigue strength at 2,000,000 cycles of 20,000 to 25,000 lb. per sq. in., are taken as satisfactory. Perhaps the most significant indication from the welded joint tests is that fatigue strengths can be raised appreciably (43 per cent in this case) if the welds are planed flush with the base plate—from 14,800 to 19,800 lb. per sq. in. On a stress cycle from zero to maximum the unplaned and planed joints had respective strengths of 23,100 and 30,100 lb. per sq. in. These strengths are for 2,000,000 cycles; for only 100,000 cycles fatigue strengths about fifty per cent higher were obtained. Fluctuating stresses of the same sign did not in any case reduce the fatigue strength below

the yield point of the material. Question may be raised, as it was with the riveted tests, respecting the fact that fatigue strengths are considerably below the yield point, which would suggest a reduction in unit stresses for members subjected to stress reversal. As we pointed out at that time, however, available tests do not throw light on the endurance limit of a member subjected to stress repetitions only a few of which reach maximum magnitude. Such a condition is the usual one in actual practice, and it may be that no damage is done and therefore the safety margin is maintained in full despite the lower fatigue strength found in laboratory tests.

Welding Economics

THERE IS ONLY ONE REASON why welding is worth consideration on every structural steel framing job. That reason is the possibility of economy. Noise abatement may justify welding in some cases and appearance may occasionally constitute a reason in others, but by and large the controlling factor in choosing welding over riveting in the structural field is to save money. That the adoption of welding has unquestionably saved money in many cases has been amply demonstrated, but the fact that some welded details that appear to the designer to assure economy turn out to be more costly than riveting by the time they go through the fabricating and erecting processes is also being realized. Some of the reasons why these added costs occur were outlined in an excellent paper by C. E. Loos, Carnegie-Illinois Steel Corp., and F. H. Dill, American Bridge Co., presented at the recent annual convention of the American Welding Society.

Basically, welding is apt to cost more than it should unless the designer makes a conscious and intelligent effort to eliminate all fabricating operations whose results contribute nothing to the serviceability of the structure. For example, with the rigid beam-column connections possible in welding, the beam depth can be made shallower toward the center of the span. This means a saving in material. But debits against this saving are the large amount of field welding necessary, the possible reinforcement or increase in size of columns, and the cost of making flange splices wherever the beam section is reduced. Welded girders must have their plate edges carefully trimmed and camber accurately cut into the web. Dimension tolerances may require the use of fillers with a consequent addition of welding. Welded trusses quite often offer economy, but unless there is enough duplication to absorb the cost of jigs the economy will be reduced or lost. Details which merely copy riveting practice usually involve a disproportionate amount of welding. Finally, unless room is allowed in the design of a detail for the shrinkage resulting from welding, extra fabricating cost may result.

The disadvantages cited do not necessarily outweigh other advantages offered by welding, but they are cost raisers of which account must be taken. The important thing is for the designer to think beyond the sketches on his blueprints to the operations that are required to translate them into tangible details. As the authors significantly point out, while present-day welded bids do not always reflect these added costs it is certain that as fabricators gain experience in welded work the costs will not continue to be absorbed but will be passed along to the customer.

Dictator Tactics

THE DICTATORS are not all in Europe. Two recent happenings with respect to public-works construction in this country show clearly that we ourselves are in danger of being subjected to dictator tactics. In Alabama, John Carmody, Federal Works Administrator, shut off funds for university dormitories being built with PWA aid until the state legislature excepted PWA power projects from the recently passed Booth Act, which sets up strict limits on new public power projects. In Oklahoma, where the Governor is trying to stop work on Denison Dam, a federal flood-control project which does not meet with the Governor's approval, Secretary of War Woodring has clearly intimated to the Governor that if he stops work on Denison Dam the War Department may stop work on all flood-control projects in Oklahoma, though there are not in controversy.

Regardless of the merits of Carmody's objections to the Booth Act or Woodring's controversy with the Governor over Denison Dam, the fact stands out that in each instance a federal officer has either threatened to use or has used his power to withdraw funds for projects concerning which there is no controversy as a club to compel action that he cannot obtain by methods that are appropriate to our system of government.

These are dictator tactics. They point to the danger of concentrating too much power over public works in Washington.

SHASTA DAM LOOKING PAST THE SITE OF THE CABLEWAY HEAD-TOWER (CENTER) TO THE EAST ABUTMENT.

Construction Progress at Shasta Dam

***Contents in Brief**—Preparations are being made for peak activity next year at Shasta Dam on the Central Valley project in California. Most of the foundation at the dam site has been uncovered, concreting equipment and a novel radial-cableway delivery system are being assembled and a proposed 9-mile conveyor belt system for delivering aggregate is being located. Concrete pouring is to start early in 1940. Work is well under way on the 30 miles of new railroad to replace the line that will be flooded by the reservoir.*

THE ZERO HOUR which now influences all construction activity at Shasta Dam is the date when traffic on that portion of the Southern Pacific railroad that will be submerged by the reservoir can be diverted to the 30 miles of new line now under construction. This date, now expected to be about Sept. 1, 1941, is controlled by the time required for completing the long tunnels and the Pit River Bridge on the new line. If railroad diversion could be made earlier, certain limitations on dam construction could be removed sooner and the date for ultimate completion of the project, now set for March, 1944, might be advanced.

Shasta Dam is being built by the U. S. Bureau of Reclamation as a major element of the Central Valley project. It is to store the waters of the Sacramento River at the northern end of California's Central Valley where storage is required because the Sacramento basin has two-thirds of the water supply of the valley and only one-third of the irrigation needs while the San Joaquin basin, at the other end of the valley, has but one-third of the water and two-thirds of the irrigation needs. In addition to storing water for irrigation and industrial purposes, the Shasta reservoir will be used to reduce flood damage along the Sacramento River, maintain sufficient dry-season flow for navigation, reduce incursions of salt water into the delta region, and develop hydro-electric power. For full details of the project see *ENR*, Aug. 19, 1937, p. 299 and Aug. 26, 1937, p. 344.

At the end of October, 1939, most of the excavation for Shasta Dam, for the power house and tailrace had been completed. Only half a million cubic yards of excavation remained of the total now estimated at 3,800,000 cu. yd. About 80 per cent of the material had to be blasted, for which drilling was done largely with wagon drills; much of the hauling was done with 25-cu. yd. dump trucks. Specifications required that spoil be dumped on the upstream side of the dam to avoid risk of later sloughing to the wasteway channel. The maxi-

mum haulage distance was 1½ miles; average haul about 3,000 ft. Limitations as to locations for spoil disposal prohibited dumping near the present river channel, within 1,000 ft. of the upstream face of the dam or above El. 1,040, which is 25 ft. below the highest water level (El. 1,065). This latter limitation keeps free of spoil that portion of the reservoir capacity that will be used for power development.

Seams in the andesite foundation rock are being carefully cleaned out and in addition to drilled grout holes, tunnels for grouting are being driven in the abutments. As a final cleanup operation, the rock surface is being sluiced off with high-pressure water jets (1¾-in. nozzle at 300 lb. per sq. in.).

At the dam site the contractor maintains a well-established camp with 132 detached houses for key men with families, and dormitories with a total capacity of about 350 single men. Many workers live in nearby communities, or in Redding 12 mi. away, to which there is a paved highway.

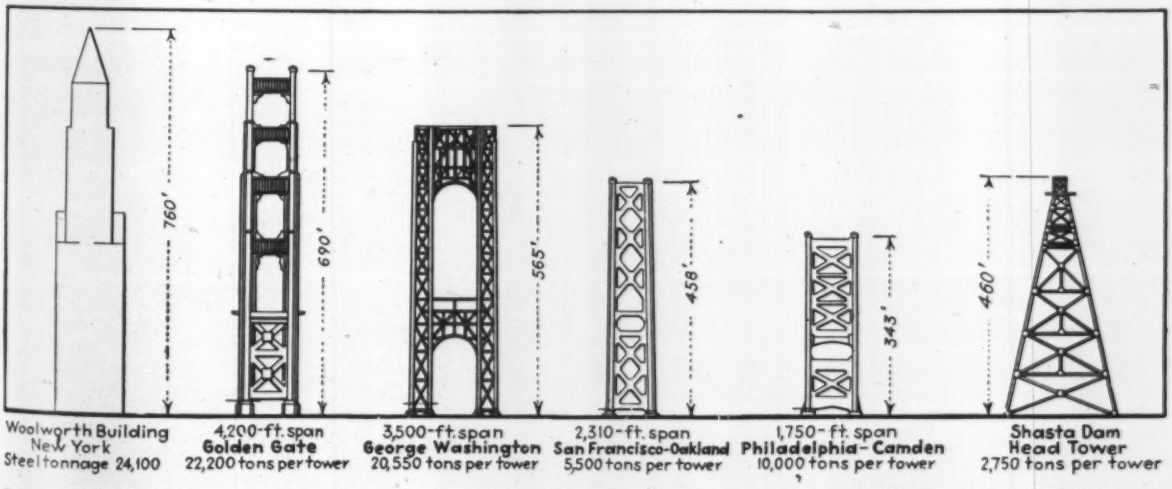
Work is advancing rapidly on the novel radial cableway system (*ENR*, May 4, 1939, p. 624) that will be used for distributing concrete to the dam in 8-cu. yd. buckets. The head-tower 460 ft. high, which will be the center for the seven radial cableways, has its four legs set at the corners of a 185-ft. square. The compression legs of the tower, which was being erected in October, have sections near the base that weigh 1 ton per lin.ft. A feature of the cableway delivery system will be the use of 60-in. sheaves in fall blocks, in carriage sheaves and for hauling lines generally, with a view to obtaining maximum cable life. Tracks for the seven movable tail towers also were being laid in October and all indications confirmed the expectation of having mixing and distribution equipment ready for placing concrete before March 1, 1940. The contractor is coordinating all parts of the concreting plant to a delivery rate of 6,000 cu.yd. per day, or 225,000 cu.yd. per month.

This 50-ton section of a compression leg in the cableway head-tower weighs 1 ton per ft. near the base.

Even more unusual than the radial cableways for delivering concrete is the 9-mile belt conveyor system (*ENR*, Oct. 19, 1939, p. 515) on which complete details were not yet available as this article was written.

Until the railroad is out of the canyon the contractor is, in effect, limited to the placement of about 1,300,000 cu.yd. of concrete because this yardage will bring the dam up to a point where interference with the railroad line would begin. Limitations (by specifications) on concreting prior to diversion of rail traffic prohibit the building up of a difference in level in adjacent blocks exceeding 15 ft. transversely of the dam, or 30 ft. longitudinally or more than 175 ft. between lowest and highest parts of the dam.

At the gravel pits in the Sacramento River bed on the easterly edge of Redding, the aggregate contractor, the Columbia Construction Co., Inc., is setting up equipment for handling 1,250 tons per hour. From the gravel deposits the material will be taken by 5 and 8-cu.yd. monighans to a pendulum feeder delivering to a primary 6-in. gyratory crusher. Ball mill and hydro separator will remove


760'
690'
565'
458'
343'
460'
Woolworth Building New York Steel tonnage 24,100
4,200-ft. span Golden Gate 22,200 tons per tower
3,500-ft. span George Washington 20,550 tons per tower
2,310-ft. span San Francisco-Oakland 5,500 tons per tower
1,750-ft. span Philadelphia-Camden 10,000 tons per tower
Shasta Dam Head Tower 2,750 tons per tower

Comparison of Shasta Dam cableway head-tower with other steel towers and with the Woolworth Building.

fines and deliver to classifiers producing two grades of usable sand, namely 4 to 24-mesh, and 28 to 48-mesh. Everything that passes through the 48-mesh is to be wasted and to assure desired quality and quantity, the smallest sand size (48 to 100-mesh) is to be a synthetic product made by grinding in a rod mill fines resultant from the crushing operation. The four aggregate sizes are (1) 6 to 3-in.; (2) 3 to 1½-in.; (3) 1½ to ¾-in.; and (4) ¾-in. to ¼-in.).

Typical berm practice in the deep railroad cuts. Note the berm, 60 ft. above the roadbed, sloped for drainage and wide enough to provide working space for equipment in removing slides.

On the railroad relocation most of the work is already under contract and good progress is being made; about a quarter of the 4,800,000 cu.yd. of grading has been done. The grading represents only about 14 per cent of the total cost of the railroad relocation. A considerable percentage of the grading was contracted at 20¢ per cu.yd.; the average for all grading was about 50¢ per cu.yd.

In making the railroad fills, some of which are 100 ft. in height, principles of soil mechanics are being applied with the result that there is only a very slight settlement (a fraction of 1 per cent) and the fills can be used for heavy hauling immediately after completion. So densely are the fills compacted that surveyors are unable to drive stakes in the roadbed and hence mark their points with nails driven into the fill much as is the custom in marking survey points on asphaltic paving.

These highly compacted fills have introduced a novel feature in problems involving "balancing the line"; instead of the old rule of allowing for ten per cent more volume in fill than in *situ*, on this job the material, after filling, occupies considerably less space than before excavation.

A total of 95,000 cu.yd. of concrete is to go into Pit River Bridge piers, of which the tallest will be 358 ft. high and will have a 90x95-ft. base. Three of the piers are so large as to require artificial cooling systems in the bases to keep concrete temperatures down during the curing period. Total cost of the Pit River Bridge is estimated at about $5,000,000. Bids on the piers were opened Oct. 5, (low bidder Union Paving Co., San Francisco, $1,138,288) and steel superstructure bids were to be invited at an early date.

A factor in the relatively low price on grading was the extensive use of large-size carrying scrapers (25-cu.yd. and at least one of 30-cu.yd. capacity). On short hauls with this equipment one man operating a tractor-drawn scraper could excavate, transport and compact in place at the rate of about 200 cu.yd. per hour.

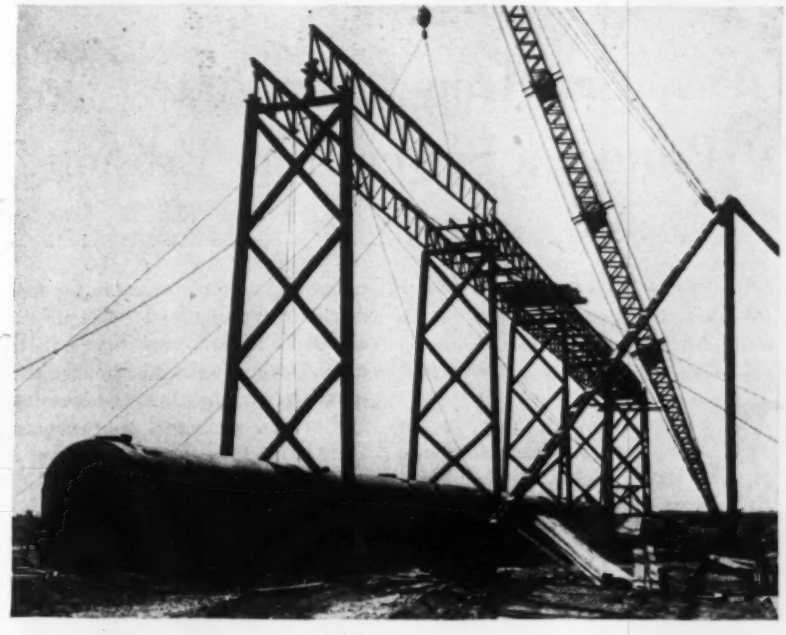
Cut slopes in general are being made 1 to 1 but vary 25 per cent either way, according to the character of the material. The railroad's original stipulation was that cuts exceeding 60 ft. deep should have an addi-

Roping a wagon drill to the edge of the cliff high up on the right abutment.

tional base width of 2 ft. for each 10 ft. of increased depth, but a later improvement on this original specification was the use of a berm 60 ft. above the roadbed in all cuts that exceeded this depth. This berm, which is made 14 to 16 ft. wide to permit equipment to handle any sloughing from higher levels, is given a longitudinal grade parallel to track grade where the grade is 0.9 per cent. On lesser grades, berms are given a 1 per cent grade for drainage. In cross-section, the berm is sloped toward the bank on a 1 per cent grade.

One exception to this slope design is in the bench cut just south of the third Sacramento River crossing where the depth is 200 ft. and a total of about 200,000 cu.yd. is being removed. Two berms are here used 60 and 120 ft. above the roadbed.

The Central Valley Project is being built by the U. S. Bureau of Reclamation under the general direction of John C. Page, commissioner, and R. F. Walter, chief engineer. Walker R. Young is supervising engineer for the project, R. S. Calland, acting supervising engineer, and Nelson B. Hunt, office engineer at Sacramento. Ralph Lowry is construction engineer of the Shasta Division, Roy M. Snell is in charge of railroad relocation and Grant Bloodgood is in charge at Shasta Dam.



Erecting steel framework for the belt conveyor over the aggregate stockpiles. Below the trestle is the reclaiming tunnel.

TECHNICAL DATA ON SHASTA DAM

Shasta Dam—The dam site, 12 miles north of Redding, required excavation of 3,800,000 cu.yd. to expose bedrock and to provide for incidental work. Design calls for a concrete structure 560 ft. high with a base thickness of 580 ft. An overflow spillway section 375 ft. long in the center of the dam will have a 480-ft. drop. On either side will be flanking abutment sections curved on a 2,500-ft. axial radius. Total crest length of 3,500 ft., transversed by 30-ft. roadway. For short lengths at either end, where foundation rock is deep, rolled earth-and-rock embankments with central concrete corewalls will be used. Total concrete for dam power house and spillway apron, 5,600,000 cu.yd.; also 1,600,000 cu.yd. of earth and rockfill.

Notice to proceed with the Shasta Dam contract was given Pacific Constructors, Inc. (combination of 12 firms) Sept. 8, 1938, on a bid price of $35,939,450. This is exclusive of materials to be supplied by the U. S. Bureau of Reclamation. Work to be completed in 2,000 days (5½ yr.); penalty thereafter $2,000 per day. Contractor's organization headed by W. A. Johnson, president, Frank T. Crowe, general manager, B. W. Goodenough, chief engineer and L. P. Sowles, assistant engineer.

Hydraulic Features—Reservoir capacity, 4,500,000 acre-ft.; spillway flow controlled by three 110x28-ft. drum gates with a capacity of 187,000 cfs at maximum water level. Steel-lined outlet conduits controlled by tube valves which will regulate normal-flow releases, will have varying capacities as water levels range from low to high.

Hydro-electric Power—Initial power installation will be four 75,000-kva generators driven by 103,000-hp turbines operating under heads of 238 to 475 ft. (Provision for one additional unit of same size.) Two 250-ton overhead traveling cranes; transmission voltage 230,000 kv, for 200-mi. transmission line to Antioch.

Concrete Materials—Contract for concrete aggregates went to Columbia Construction Co., Inc., Oakland, on a bid price of $4,413,520. Materials, to come from North Kutras tract near Redding, include 7,600,000 tons of gravel (4 sizes) and 2,800,000 tons of sand. Delivery to the dam is to be at a maximum rate of 22,000 tons per day. Delivery will be into a boot (or track hopper) at Coram, just downstream from the dam whence 7,000 ft. of 36-in. conveyor belt (capacity 1,000 tons per hour) will deliver to stockpiles and to the mixing plant (five 4-cu.yd. mixers) high up on the right abutment of the dam.

Cement contract, held by the Permanente Corp., calls for 5,800,000 bbl. of low-heat Portland cement to be delivered at a maximum rate of 11,000 bbl. (50 carloads) per day; to be unloaded by pneumatic process, delivering through an 8-in. steel pipe to ten silos where provision for blending is being made and whence cement will be blown through an 11-in. pipe 3,200 ft. long to the mixing plant.

Concrete Delivery Methods—The concrete mixing plant will be alongside the steel tower 460 ft. high, from whose top seven concentric cableways will extend out over the dam. Movable tail towers will enable the 8-cu.yd. buckets to reach all parts of the dam except a small area in the power house which may be served by a 20-ton derrick with a 185-ft. boom. The head-tower will be square in plan, 185 ft. on a side at ground surface and will contain 2,750 tons of structural steel. Cableways will include 13,500 ft. of 3-in. track cable (cost about $5 per foot) and 115,000 ft. of ¾ to 1⅛-in. operating lines. The latter are estimated to require 8½ replacements during the job thus making a total of 977,500 ft. of operating cable.

Lengths of the seven main cableways will vary from 2,670 ft. to 720 ft. Tail towers will swing through arcs of 21 to 42 deg.; cableways are designed for working loads of 2 tons at hoisting speeds of 300 ft. per min. and carriage speeds of 1,200 ft. per min. Cableways will pick up the buckets from cars on a circular track passing from beneath the mixing plant around a levelled area at the base of the tower.

Rail and Highway Relocation—The 37 miles of Southern Pacific main line railroad in the Sacramento River canyon, part of which will be flooded by the reservoir, is being replaced by 30 mi. of new line passing around the reservoir on the east side (*ENR*, Sept. 28, 1939, p. 402). U. S. highway 99 is similarly being relocated and will share with the railroad the Pit River Bridge over an arm of the reservoir. At the dam site the railroad is now using an 1,820-ft. bypass-tunnel driven under the right abutment. When railroad operation is transferred to the new line the bypass-tunnel will be used for diverting the river. Specifications contemplate that the new line will be ready for traffic by Sept. 1, 1941.

The relocated rail line includes 12 tunnels and 8 major bridges. The Pit River Bridge is to cost about $5,000,000; the lower deck will carry two tracks, the upper deck, about 500 ft. above streambed, will have a 44-ft. roadway and a 2½-ft. walkway on either side. Piers will require 95,000 cu.yd. of concrete, 3,600 tons reinforcing steel and 16,400 tons structural steel.

Overall costs on the dam are roughly estimated at $80,000,000 and on rail and highway relocation at about $20,000,000.

Cast Iron Liner Plates Protect a Sewer from Erosion

Contents in Brief—Curved plates fastened to a worn invert with wrought iron pins put a pressure sewer back into service.

WEARING OF A CHANNEL in the bottom of a sewer discharge pipe by sand, brick and other abrasive debris gave officials of the New Orleans Sewerage & Water Board a problem that was solved by fastening a plate along the bottom, an operation costing about $50,000 as compared with an estimated $700,000 replacement cost for the entire affected structure, according to Baldwin Wood, general superintendent.

The structure involved was a 4,000-ft. 48-in.-diameter cast iron discharge pipe extending to the Mississippi river at Asplanada Ave. from the Orleans pumping station. This pipe had been in service since 1907, sustaining full capacity velocities ranging from 4 to 8 cfs, and with a slope of 11 ft. in the entire 4,400 length. The point of discharge into the river is above the pumping level, the slope being uphill.

Investigation of breaks in the main disclosed that except for distances of about 30 ft. following bends in the main, which were undamaged, the scouring action of heavy particles had eroded a channel approximately 18 in. wide to such an extent that an original pipe thickness of 1⅛ in. had been reduced to as little as ¼ in. in places. Failure to sustain pressure occurred in these places.

The board, said Mr. Baldwin, faced the problem of finding some means of repairing the damage, or else replacing the entire main, which would have involved tearing up streets at substantial costs. Use of concrete was tried, but while this material met the scouring test, it lacked the strength to withstand the pressure. The solution arrived at was to design curved cast iron plates to be fastened to the inside of the main surface with wrought iron pins.

This was effected by cutting in headings each 1,400 ft., except where turns required closer spacing, so that work could be carried on for a distance of 700 ft. from each opening.

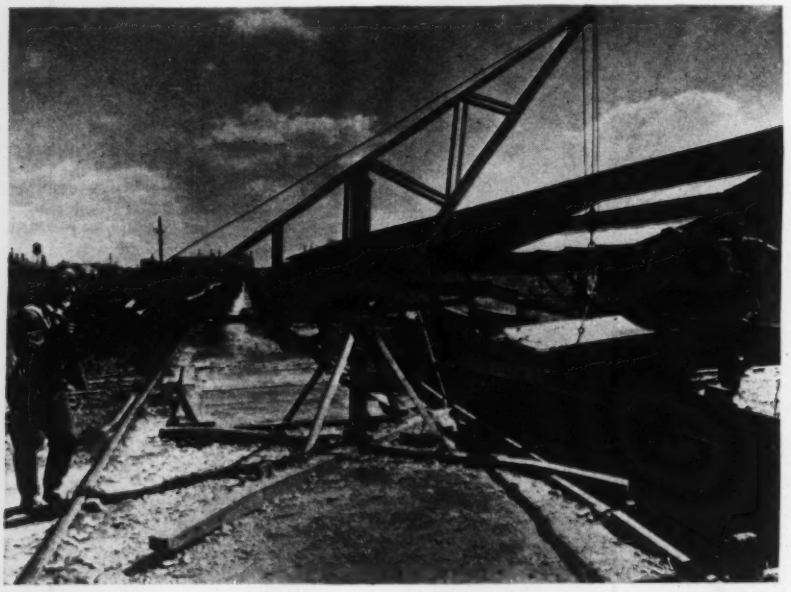


Fig. 1. Portable hoisting rig lowering one of the curved cast iron plates used in the relining operation.

Fig. 2. Dolly carrying workman and plate (slung underneath) into the 48-in. sewer.

Ventilating fans were put in, a compressed air hoist rigged, electric lights strung, and a dolly designed to carry the plates to the proper places for lowering. With this equipment a crew of six men and a foreman lined the entire pressure main in about six months' working time.

Another novel method of repairing a disintegrated sewer invert using iron flume "half soles" was described in ENR, *April 13, 1939, p. 488.*

. . .

Nebraska City Zones Beyond Municipal Limits

Municipal zoning of land outside the city limits is reported to be successful in Lincoln, Neb., by the American Society of Planning Officials. Seven years ago, the Nebraska legislature enacted a special law which gave the city of Lincoln the right to regulate the use of property in an area three miles beyond its boundaries.

The Lincoln city council subsequently passed an ordinance placing the three-mile area in the residential district, subject to all provisions of the zoning ordinance. Farming is one of the uses permitted, however, and permits for filling stations or other business buildings found necessary are granted by the city board of appeals.

A number of cities control platting of subdivisions beyond their limits, the society said, but Lincoln is unusual in having zoning control also.

Fifty Years of Waterworks Advance

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Upper Montclair, N. J.

***Contents in Brief**—An analysis of the growth in waterworks and purification facilities in the United States from 1890 to 1939 showing periodic changes in ownership since 1800. The author was editor of the several issues of The Manual of American Water Works which had its beginning in 1888.*

THANKS to the waterworks inventory published in *Engineering News Record* (Sept. 28, 1939, p. 414), it is now possible to note significant changes in the water supplies of the cities of the United States in the past half-century, and to review the status of ownership for nearly a century and a half. Nothing so complete as this inventory has appeared since *Engineering News* published *The Manual of American Water Works* for 1888, 1889–90, 1891 and 1897.

The 1939 inventory gives data for 12,760 waterworks supplying 13,293 municipalities. At the close of 1890 there were 1,878 works supplying 2,187 communities—this is a sixfold increase in 49 years. The population supplied in 1890 was 22.5 millions out of 69.9 millions for the whole United States, or 22 per cent. Today a total of 81.4 millions, or 66 per cent of the 122.8 millions shown by the 1930 census, are supplied with public water service.

More striking than the increase in number of waterworks and population supplied in the past fifty years is the growth of water treatment. In *The Manual of American Water Works* for 1889–90 there were listed 191 places in the United States as having some kind of filtration. Based on present-day standards the number would be reduced to 57, of which 3 were slow sand and 54 rapid or mechanical filters. There were, however, a number of filter galleries, 39 of which were built on the assumption that they served as "natural" filters for water from adjacent streams but all of which were in greater or less degree collectors of groundwater.

In contrast, the 1939 inventory shows 97 slow sand and 2,091 mechanical filters or a total of 2,188 among the 12,760 waterworks—a ratio of nearly 1 to 6. Moreover, 4,015 works chlorinate and 39 otherwise disinfect the water they supply. Nearly twice as many works disinfect as filters. However, there are few filter plants that do not disinfect also, and so it can be assumed that there is a large measure of protection of unfiltered supplies. It must not be forgotten that there was no disinfection until 1908!

A half-century ago, water treatment was directed chiefly to turbidity removal, with a dawning sense that filtration would also remove bacteria and curtail the high typhoid toll then prevalent. Color removal was the object of some of the mechanical filtration plants. Broadened aims of water treatment today are shown by the existence of 484 softening plants, 298 for the removal of iron and 19 to remove manganese. Of this total of 701, some serve two or more of the purposes named.

In 1890, tastes and odors due to algae and other micro-organisms were causing much trouble at many plants. Alga control had long been the object of study by a few pioneers but with little tangible result. Not until the advent of copper sulphate in 1904 was the control of algae made possible. It is amazing to note that today 551 works use ammonia and 631 employ activated carbon for taste and odor control—both recent innovations.

Changes in water quality

Two important factors affecting the quality of water during the last half century have been the large increase in the number of sewerage systems which have added immensely to the pollution of surface water supplies, and the parallel increase in sewage treatment plants, which has partly offset the growing burden of pollution. Fifty years ago only 650 towns were listed in the 1889–90 *Manual of American Water Works* as having sewers while 816 reported a lack of these facilities; incidentally, hundreds did not report on the subject—probably through shame.

Early sewage treatment

In a series of articles on sewage purification in America, written by the author and published in *Engineering News* in 1892–93, it appears that in 1890 only 20 municipalities in the United States treated their sewage. In about half those towns the object was to utilize the sewage for irrigation. All but one of the treatment works had been built between 1881 and 1890. The largest city was Worcester, with about 85,000 inhabitants in 1890. Contrast this with the latest inventory of sewage disposal (*ENR*, Jan. 19, 1939) showing that in 1938 there were 4,662 communities in 47 states that had sewage works. These communities had a total population of 41 million in 1890. They included some of the largest cities in the country.

The typhoid death rates of most American cities in 1890 ran up to astounding heights. Happily the latest statistics (*Jour. Am. Med. Assoc., May 13, 1939*) show that of the 93 cities of the United States having populations of 100,000 or more in 1930, there were 29 or nearly a third that did not have a single typhoid death in 1938, while 48 more had rates under 2 per 100,000 living and but one had a rate as high as six. Although by no means all of this remarkable decline was due to better water, treated or untreated, much of it came from improved quality.

Underground sources were drawn on by 6,842 of the waterworks covered by the 1939 inventory against

3,421 surface supplies besides which the origin of 208 supplies was not given. Corresponding figures in the 1888 *Manual* were 684 underground, 907 surface and 52 unknown. Of the known sources in 1939 the ratio of ground to surface waters was 2.4 to 1, against 1 to 1.3 in 1888. This change in ratios is largely due to the growth in the last half-century of waterworks in what may be described as the southern and central states, the latter extending from Ohio to Colorado and Montana. Nearly all groundwaters are furnished to small cities, the largest being Memphis, Tenn., and Houston and San Antonio, Texas.

Ownership of the 12,760 waterworks shown by the 1939 inventory stands at 9,336 public and 3,424 private, or 2.7 to 1. In 1890 there were 1,878 works, of which 806 were under municipal and 1,072 under private ownership or 1 public to 1.2 private.

How waterworks grew

Going back to data for 1800, there were just 16 waterworks at that time, of which only one was publicly owned. Growth in number of works was so slow before the Civil War Period that only 130 towns were supplied with water in 1860. From 1860 to 1870 plants increased to 243, despite the fact that construction was almost at a standstill from 1860–65, as it was in 1811–15, which included the period of the War of 1812. By 1880, there were 598 waterworks in the United States. Then came the rapid expansion to 1,878 works in 1890. These end the figures for census years. At the close of 1896 there were 3,179 complete works besides about 200 that were for domestic and a smaller number for fire supply only —distinctions not made before or since.

Starting with percentages of 6.3 municipal to 93.7 company-owned works in 1800, there was only one break (1811–20) in public ownership increase until the 1880 record stood at 49 per cent public to 51 per cent private. In the next ten years threre was a percentage decline to 43 public against 57 private.

The 1881–90 decade was one of increasing waterworks franchise grants to private companies. These grants were stimulated by manufacturers of pipe and pumps and by general contractors. Some "parent" companies, as they were called before the use of the term "holding," obtained many franchises and built and operated many works. Further details regarding the growth of waterworks are presented by the accompanying table and curves.

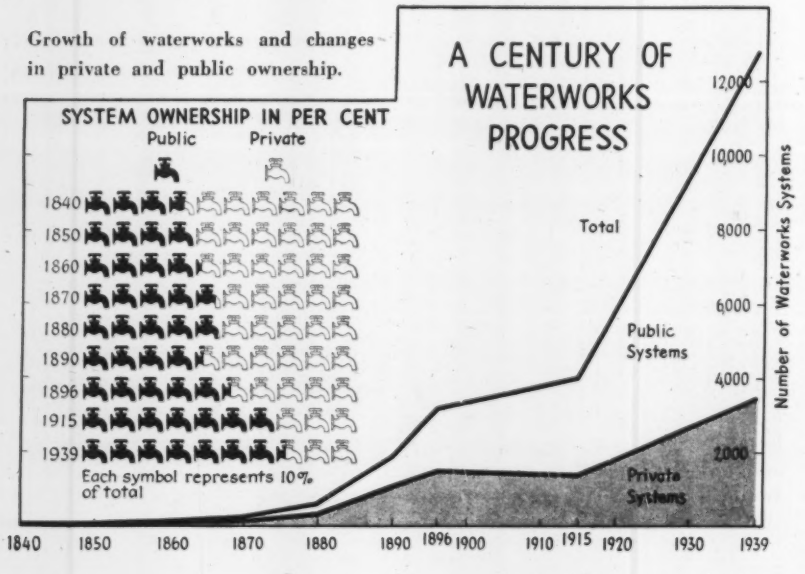
In closing this review, tribute may well be paid to the many engineers, analysts, manufacturers and contractors who have contributed to advances in waterworks design, construction, and operation—advances not visioned a half-century ago, much less in 1800. Hearty thanks are due to the state sanitary engineers who so ably summarized for each commonwealth the data presented in both the water supply and sewage disposal inventories compiled and published by *Engineering News-Record*.

WATERWORKS GROWTH AND OWNERSHIP 1800-1939 *

				Percentages	
	Public	Private	Total	Public	Private
1800	1	15	16	6	94
1810	5	21	26	19	81
1820	5	25	30	17	83
1830	9	35	44	21	79
1840	23	41	64	36	64
1850	33	50	83	40	60
1860	57	79	136	42	58
1870	116	127	243	48	52
1880	293	305	598	49	51
1890	806	1,072	1,878	43	57
1896	1,690	1,489	3,179	53	47
1915	3,045	1,355	4,400	70	30
1939	9,336	3,424	12,760	73	27

* The figures are for the United States. Those for 1800 to 1897 are from *The Manual of American Water Works;* for 1915, from the *McGraw Waterworks Directory;* for 1939 from the *Engineering News-Record Inventory of Water Supply Facilities.* Owing to slight differences in classification for the various dates, particularly the use of towns supplied instead of number of works in some years, not all the data are strictly comparable but they suffice to show trends.

Growth of waterworks and changes in private and public ownership.



Effect of Land Use On Floods Studied

Surveys to determine what effect proper use of land may be expected to have upon the frequency and severity of floods are now under way in eighteen watersheds as part of the joint study being made by the Bureau of Agricultural Economics, the Soil Conservation Service and the Forest Service, it was announced by the Department of Agriculture on May 31. These studies are being conducted under authority of the Flood Control Act of 1936.

Eventually, the surveys will cover 200 major watersheds. Already preliminary examinations have been made in 75 watersheds, and final reports on at least six will be completed this year. The surveys are seeking to determine such questions as the amount of forest cover, extent of erosion, the kind of agriculture, possibility of improved land use, and the effect of these features upon runoff, as well as economic estimates of flood damage.

The watersheds now being studied are those of the Merrimac River in New England, the Youghiogheny in Pennsylvania and West Virginia, the Coosa in Georgia, the Codorus in Pennsylvania, the Upper Yazoo in Mississippi, the St. Francis in Missouri, the Kickapoo in Wisconsin, the Washita in Oklahoma, the Trinity and Concho in Texas, Fountain Creek and Cherry Creek in Colorado, the Upper Gila in Arizona, the Rio Puerto in New Mexico, the Boise in Idaho, the Los Angeles, San Gabriel and Santa Ana in Southern California, the Muskingum in Ohio, and three streams near Buffalo, N. Y.

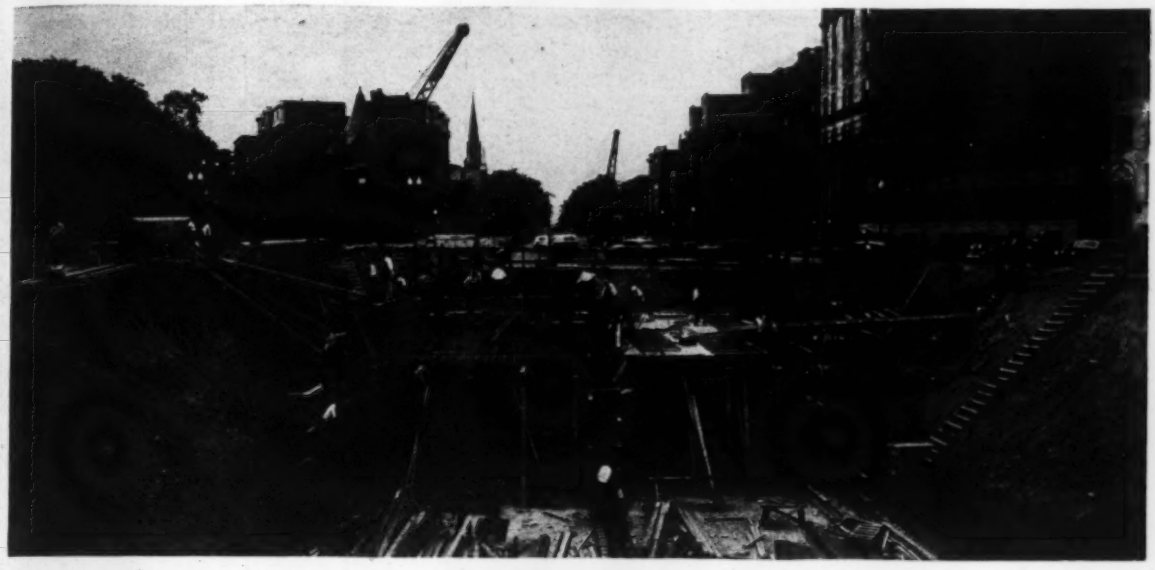


FIG. 1. TWIN-BOX UNDERPASS TO CARRY MASSACHUSETTS AVE. UNDER THOMAS CIRCLE IN WASHINGTON.

Grade Separation at Thomas Circle

***Contents in Brief**—Thomas Circle in Washington is the first job to be tackled in a plan to separate grades at some of the most congested traffic circles in Washington, D. C. Construction work is being carried on in such a way as to offer minimum interference to the flow of traffic. The structure to carry Massachusetts Ave. under the circle is a concrete box providing two 21-ft. roadways. The restored circle will be streamlined as an ellipse.*

BUILDING OF AN UNDERPASS to carry Massachusetts Ave. beneath Vermont Ave., 14th St. and M St. at Thomas Circle in Washington, D. C., is the first step being taken by the district officials to adapt Major L'Enfant's plan of radial highways and traffic circles to modern traffic requirements. This grade separation is one of several to be undertaken at the more congested multiple intersections in the national capital, all involving Massachusetts Ave. (*ENR*, Oct. 26, p. 528). When the Thomas Circle project is completed, Massachusetts Ave. will pass under the circle in a double concrete box and the former circle will be elongated in the direction of 14th St., second heaviest traveled street of the four. Streamlining of the circle will reduce the swing of the street cars.

To make room for the underpass and surface connections, the roadway of Massachusetts Ave. has been widened to 92 ft., curb to curb, by moving the sidewalks back toward the building line. At Thomas Circle, Massachusetts Ave. has a right-of-way width of 160 ft., is a residential street, and all buildings are so far back that none was disturbed. On the north side of the avenue, west of the intersection, Highland Terrace is a marginal street that is elevated above the avenue by a stone wall. Widening of the avenue required removal of part of the old wall and construction of a new granite-faced concrete wall in its place.

The underpass is a double concrete box, 415 ft. long, carrying two roadways separated by the center wall. Each roadway is 21 ft. wide, flanked by a curb 13½ in. wide at the center and 2 ft. 4½ in. wide at the outside walls. Outside walls are 2 ft. 2 in. thick; the center wall is 1 ft. 3 in. Top and bottom slabs are 2 ft. 9 in. thick. The structure is completely encased in three-ply membrane waterproofing, protected at the bottom by a 6-in. layer of concrete, at the top by a layer 2 to 3 in. thick, and at the sides by one 4-in. course of brick. Inside walls are covered with ceramic tile. The ceiling has a smooth concrete finish and the roadway has a 4-in. concrete wearing course on top of the structural slab. For drainage, the roadways slope toward the outer curb, also toward the east portal; clear height of roadway varies from 13 ft. 4 in. to 13 ft. 6½ in. The lowest point of roadway is 21 ft. below street grade. Illumination of the underpass is by recessed lights placed in the corbels at both center and side walls. A cross-section of the structure is shown in Fig. 4.

Each half of the roadway will be ventilated by four 48-in. disk-type fans recessed into the ceiling. These will exhaust foul air from the traffic area through ducts in the top slab terminating in a vent in the park area of the circle. Each fan, driven by a 3-hp motor, has a capacity of 20,000 cfm. Fresh air will be taken in through the portals. The fans will be operated only when the carbon monoxide concentration exceeds 0.02

Fig. 2. Construction of the approaches was by stages to keep heavily-traveled Massachusetts Ave. open to traffic. This view shows early stages in building the west approach. Traffic has been shifted to the center lane; in the foreground the north wall of the ramp is shown under construction and at the left is the new Highland Terrace wall. The space between the two walls represents the widening on this side of the avenue.

per cent (2 parts in 10,000). The eight units will be automatically regulated by four CO control instruments and two CO analyzers and recorders which will make continuous tests and a continuous recording of CO concentration but will turn the fans on only when the concentration exceeds the determined limit. Likewise, they shut off the fans when the CO is reduced to 0.02 per cent.

Drainage will be by two 3,000-gpm pumps, electrically driven. The pumps are equipped with automatic controls working through float valves in the sump.

The approaches are open cuts, full width of both roadways, on 6.5 per cent grades, 270 ft. long on the west and 334 ft. long on the east. A center curb separates the roadway. The cuts are retained by cantilever concrete walls faced with sawn granite capped with a granite coping surmounted by an iron railing. Along each side of the approaches are side roads at street grade connecting Massachusetts Ave. with the other intersecting streets.

As usual, numerous utilities were present under the streets and had to be taken care of temporarily and then relocated. These included a 36-in. cast iron water main which was bypassed and subsequently replaced by a steel pipe over the underpass, a 4½x5-ft. brick sewer, placed underneath the structure, two more smaller brick sewers, two clay pipe sewers, power lines and telephone, telegraph and fire alarm signal ducts. The double track street railway line on 14th St., with underground third rails, also had to be moved.

Construction

Construction operations are fairly simple, but they involved two problems in planning. First was the planning of operations to permit free flow of traffic in all directions; second was the planning of operations hampered by lack of working space.

The general construction plan was first to move the statue of General Thomas, weighing 550 tons with its

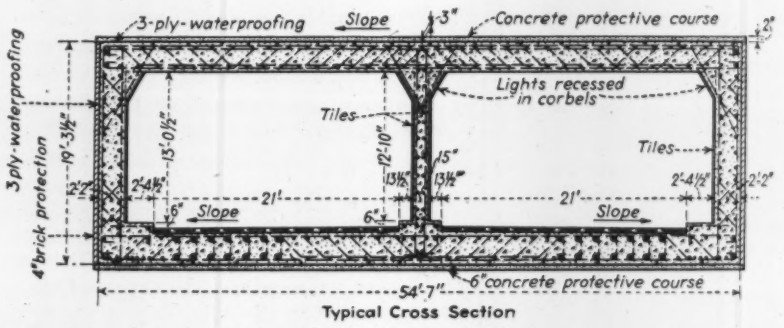


Fig. 4. With 21-ft. roadways and the traffic in opposite directions separated, the underpass will have a large traffic capacity. Details of the structure are shown here.

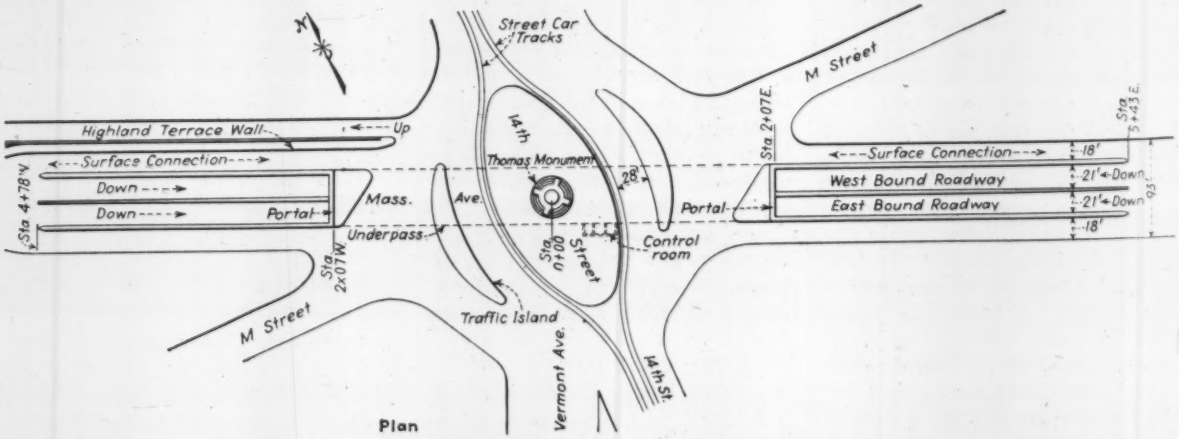


Fig. 3. Traffic will flow through the multiple intersections at Thomas Circle now that Massachusetts Ave. passes under the intersection and the circle has been streamlined for easier passage through 14th St.

Fig. 5. The double box under the circle will be lined with tile, lighted and mechanically ventilated. Note the brick waterproofing protection on the subway walls. On top of the box is the brick base for the General Thomas statue that has long dominated the circle.

stone base, from its location at the center of the circle to one side, out of the way of the cut. Then all the utilities that interefered with construction within the circle were taken care of. The first section of underpass to be built was the center portion between the existing street car lines. After this part had been completed, the car tracks were shifted to their new position over the structure and roadways were rearranged to permit completion of the end-sections of the concrete box forming the underpass.

Meanwhile utilities interfering with approach wall construction were removed and the walls were started. Only one wall at each approach could be built at a time. They were built in sheeted trenches far in advance of general approach cut excavation. The north wall on each end was tackled first, utilizing the future marginal road as working space and throwing Massachusetts Ave. traffic to the center and opposite side. Construction of the Highland Terrace wall proceeded with that of the north wall of the west approach. After the first wall had been built on each approach, the north marginal roads were immediately paved and utilized for westbound traffic, while eastbound traffic used the center of the avenue. This cleared traffic for construction of the south wall on both approaches. After these walls were completed and the south marginal roads had been opened to eastbound traffic, excavation of the approaches could proceed.

Most of the excavation was done by crane and clamshell, loading into trucks. The material was various mixtures of sand and clay, all dry enough to make pumping unnecessary except in lowest footings and during storms. As far as possible, excavated material was used for backfill around completed parts of the structures.

Wood panel forms were used for the inside of the underpass walls, elsewhere wooden forms were built up as needed. Plywood facing was used on the ceiling. Although specifications permitted building of the brick waterproofing protection first, applying the fabric to the brick and pouring concrete against this face, the contractor elected to apply the waterproofing to the concrete and build the brick protection just in advance of back-filling. Concrete aggregates were delivered to the job in truck mixers and the mixing was done at the site.

Direction

The Thomas Circle improvement is being built for the commissioners of the District of Columbia, Col. David McCoach, Jr., engineering commissioner, by the Department of Highways, under the direction of H. C. Whitehurst, director of highways and C. R. Whyte, engineer of bridges. N. G. Tayman is resident engineer. Plans were prepared by Parsons, Klapp, Brinckerhoff & Douglas, consulting engineers, New York. James Stewart & Co., New York, is contractor. Joseph M. Cunningham is superintendent for the contractor, assisted by J. F. Fry.

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Plaster Models Used In Tests of Concrete Slabs

Model slabs of pottery plaster have been used in studies of reinforced concrete slabs under concentrated loads, as part of an investigation conducted by the University of Illinois in cooperation with the U. S. Bureau of Public Roads and the Illinois State Division of Highways. Methods and results of the tests are described in Bulletin No. 313 of the Engineering Experiment Station of the university, by Nathan M. Newmark and Henry A. Lepper, Jr. To supplement mathematical analyses by model experiments, it is necessary to use a material having properties that accord with the assumptions made in the analyses.

When pottery plaster is used for tests of this kind, there is no necessity for measuring strains, as the intensity of maximum tensile strength is equal to the strength of the plaster, and this stress corresponds to the ultimate load on the specimen just before rupture. An objection to this plaster has been its lack of homogeneity, due to entrapped air bubbles, but high-frequency mechanical vibration applied to the mixing tub causes escape of this air and produces a very dense material. Although the behavior of a reinforced concrete slab at ultimate loads is different from that of a plaster model slab at failure, there is a similarity in behavior of the plaster slab up to failure and the concrete slab at working loads. Thus the loads causing rupture and the manner of failure of the plaster slabs should give qualitative indication of the action of reinforced-concrete slabs.

It appears then that the plaster model method affords a simple and inexpensive means of obtaining an approximate value of the maximum tensile stress in slabs as long as the behavior of the model is elastic. A fair agreement has been found between computations and tests.

Elevation Control for Improvements In Floodwater Check Reservoirs

C. S. BENNETT
Engineer, The Miami Conservancy District, Dayton, Ohio

Contents in Brief—In order to prevent undue damage to structures during high-water periods in the five floodwater check reservoirs of the Miami Conservancy District, the engineers have decreed that no building can take place below a contour five feet below the crest of spillways. They have placed in the area a system of benchmarks which make it unnecessary to run more than a half mile of levels to obtain the floodwater elevation at a proposed building site.

TO AID IN ENFORCEMENT of Miami (Ohio) Conservancy District regulations with regard to the location of buildings, engineers of the district have installed a system of benchmarks which make it unnecessary to run more than a half mile of levels to obtain the limiting elevation of a given point.

The flood control works of the Miami district include five retarding basins or "dry" reservoirs in which floodwaters are stored only intermittently. Nearly all floods in this area occur during the winter and early spring seasons, thus leaving the lands in the basins free from overflow during the major part of the growing season. As these basin areas are for the most part good agricultural lands, full use is made of them with a few necessary restrictions. There are about 55,000 acres of farm lands in the basins which are either owned by the district or are subject to certain easement rights purchased at the time the dams were constructed. Of this area, about 35,600 acres would be covered with backwater in a maximum flood—one which would be 40 per cent greater than that of 1913.

One of the principal limitations contained in the flood easements held by the district is a regulation which prohibits the erection or maintenance of buildings on those basin lands which lie at elevations lower than 5 ft. below the spillway crest of the dam. Ownership of these lands changes frequently and many of the larger units are subdivided and sold in smaller portions. Thus it is necessary to maintain a regular and careful check on building operations to insure the observance of the restrictions as to building sites. Many times the necessity arises for the determination of exact elevations of proposed structures.

Benchmark system

A comprehensive system of permanent benchmarks has been established by the district to facilitate the rapid and easy determination of elevations. These benchmarks are so located that any point within each retarding basin may be reached by running less than one-half mile of levels. Descriptions and location maps of the benchmarks have been prepared and made available to public and private engineering offices in the Miami valley.

The basis for the benchmark system is the series of benchmarks established by the U. S. Coast and Geodetic Survey and the U. S. Geological Survey, descriptions of which are collected in the Final Report, Volume II, of the Ohio Cooperative Topographic Survey. A sufficient number of these benchmarks exists in the area to form control points for the various level networks in each basin.

Four-foot precast concrete benchmarks used by the Miami Conservancy District.

Ordinary leveling methods were used in running primary circuits connecting the U. S. benchmarks. The instruments used are 17½-in. monitor-type dumpy levels with erecting lenses. Invar-type rods were used. All lines on primary circuits were run independently in both forward and backward directions and foresight and backsight distances were equalized. As most of the work was done during cool weather, little difficulty was had with level bubble control or aberration.

The precision required for primary circuits was that prescribed for second order leveling in the standard specifications of the U. S. Geological Survey. This permits a limit of error of 0.035 ft. times the square root of the length in miles. Circuits were adjusted between existing U. S. benchmarks, the elevations of which were accepted in all cases except where it was evident that the existing benchmark had been disturbed.

Where bridge abutments or other permanent structures were not available for benchmarks, precast concrete monuments were used. These are of rectangular section, 6 in. square at the top, increasing to 8 in. square at the base, and 4 ft. long. The tops are slightly convex. A brass bolt is imbedded in the center of the top. These monuments are set in dug holes which are carefully backfilled and then tamped. They are usually set with top face about flush with the top of the ground.

All permanent benchmarks were assigned numbers and a card index was prepared, each card bearing complete data and description. The card system was employed to provide flexibility of the record. Whenever a benchmark is destroyed or for some reason becomes obsolete, the descriptive card is removed from the file, thus maintaining a live file at all times. Index location maps were made, using U. S. Geological Survey quadrangle sheets. Benchmark numbers were spotted on these sheets at the proper locations. The sheets were then copied by photostat to convenient size for field use.

FIG. I. TRICKLING FILTER INCLOSURE AT HIBBING, MINN., SEWAGE DISPOSAL PLANT.

Elliptical Concrete Domes for Sewage Filters

ERIC C. MOLKE

Structural Engineer, Roberts and Schaefer Co., Chicago

Contents in Brief—Two thin-shell elliptical concrete domes, 150 ft. in diameter, cover trickling filters at a new sewage disposal plant for Hibbing, Minn. Elliptical shape eliminates horizontal thrust at base. Design complicated by openings at top and bottom. Form system and concrete placing simple. Reasons given for filter enclosure.

TO PROTECT the trickling filters of the new Hibbing, Minn., sewage disposal plant against severe winter weather of the Lake Superior region, the filters have been covered with two thin-shell concrete domes of elliptical cross-section, 150 ft. in dia. A dome is the simplest form of roof, and in this case the elliptical shape was used for economy in design. Ventilation facilities, consisting of an opening at top surmounted by a lantern, and louvres at the bottom, complicated the design. Shell thickness varied from 3½ to 6 in.

The simplest problem for a dome is a full sphere under internal or external pressure. When a segment of a sphere (flat dome) is used the problem becomes difficult if the relative displacement of the base ring and shell due to load, temperature or other discontinuities at the base is considered. These elastic movements must be taken care of in the calculation, no matter how strong the base may be. Shell forces act only along the surface of the dome without any components normal to the surface. The reaction along the base of a hemisphere is therefore vertical and does not exert any outward push as in the case of a shallow segment of the sphere. The hemisphere, therefore, does not need a heavy base ring. With a radius of 150 ft., such as called for in covering the Hibbing filters, a hemisphere would have been 75 ft. high, a very uneconomical roof structure.

A dome height of 32 ft. was chosen for this structure, and a solution could have been obtained by using either a shallow segment of a sphere or, as finally decided upon, by using an elliptical cross-section with vertical shell walls at the base. The latter has the advantage that no base ring is necessary, as explained above. This permits great flexibility where the light shell walls join the heavy substructure. Such flexibility is necessary to eliminate a dangerous straining of the shell due to the difference in temperature between the substructure and the shell. The substructure, in general, is of substantial dimensions, embedded in earth, while the roof structure consists of a very thin concrete membrane. There will always be a lag in the temperature variation of the solid base walls and of the concrete shell, and if there is not sufficient flexibility at the connection, one or the other will be dangerously strained.

As shown in Fig. 2, the cross-section is composed of four parts with different radii so that the shape of the shell very nearly approximates an ellipse. Ventilation openings were liberally provided by means of a large lantern at the top and 35 louvre openings 6 ft. wide and 2 ft. high around the base of the dome. About half of the shell is 3½ in. thick, but the thickness increases to 6 in. at the base and to 5 in. at the ring supporting the lantern.

Distribution of the ring stresses is also shown in Fig. 2. The merid-

ional stresses are compressive over the whole surface of the shell, while the ring stresses are compressive only in the upper part of the dome and are tensile in the lower half, just like the longitudinal stresses in an ordinary beam. In fact, a dome could be considered as a girder in space. It should be noted that the diagram for the ring stresses is not a continuous line but the sum of different wave lines which have their origin at points of discontinuities, such as the border of the shell top and bottom, and at such points where changes in thickness or radii occur.

If the sum of the compressive stresses in the diagram does not equal the sum of the tensile stresses, the ring members in top and bottom of the shell must take the difference. For a flat spherical shell segment, the ring stresses would be all compressive, as can be concluded by considering the upper part of the stress diagram. In order to balance this compression a heavy tension ring would be necessary at the bottom, causing a jump in stresses between ring and shell. By using the elliptical shape, no such jump occurs and the stresses change very gradually. Each marked change in ring stresses, such as the wave near point of discontinuity, brings about stress components normal to the concrete surface which cause bending stresses in the shell. The occurrence of these bending moments is one of the reasons for the thickening of the shell near the borders, and if the shell is not properly shaped they may reach considerable magnitude. Another reason for thickening of the shell near the lower edge is that resulting increase in dead weight will automatically decrease such bending moments which occur due to a decrease in shell radius. (Vol. 34, p. 692, American Concrete Institute *Proceedings*).

A difficult design problem on this structure was the proper layout around the ring of the lantern on account of the shear and moments caused by the weight of the lantern structure. A mere increase of the thickness does not help, as this means only increase of dead weight and, furthermore, a thickening of the shell will immediately cause heavier moments on account of the increase in stiffness. In general, a saving in material is not the primary object in keeping the shell thin. The main pur-

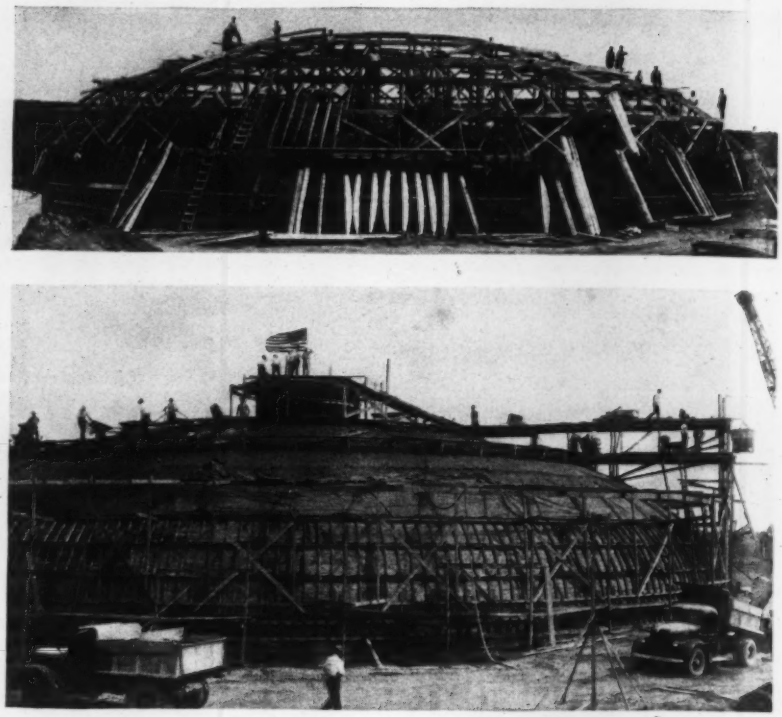


Fig. 3. Construction of elliptical thin-shell concrete domes for Hibbing sewage plant. Top view shows form system, simply ribs sawed to desired curvature supported by ring joists carried on posts. Top or outside forms were required only on lower 12 ft. of shell, as shown in bottom view. Concrete was hoisted to platforms in a bottom-dump bucket and distributed by buggies and wheelbarrows.

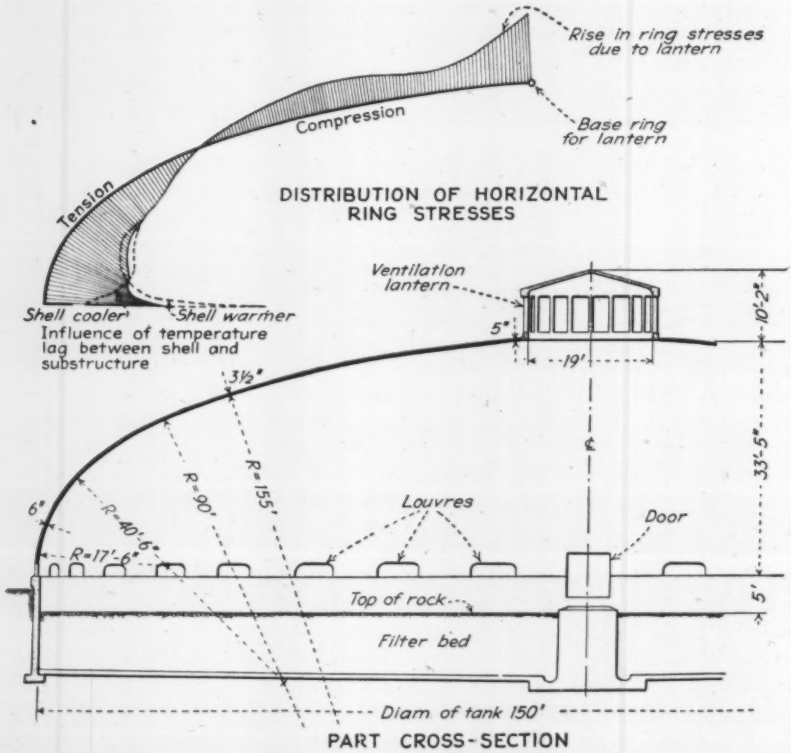


Fig. 2. Diagram of shell stresses and cross-section of dome. Note how the shell thickens toward the bottom ring and top lantern.

pose is to keep dead weights down and to obtain sufficient flexibility to overcome secondary stresses normal to the surface of the shell. Incidentally, the louvre openings near the base of the dome cut the shell into small strips about 7 ft. wide, which have enough flexibility to permit a breathing movement of the dome. It was therefore possible to anchor these wall strips with steel dowels into the substructure instead of using a horizontal sliding joint at the base.

The reinforcing in the shell consists of four layers of round bars, two meridional and two ring. All meridional bars are ⅜-in.; the lowest ring is ⅜-in., in the lower thicker part of the shell the ring steel is ½-in. and for the remainder is ⅜ in. In the 3½-in. shell thickness the layers rest against each other, leaving 1 in. of concrete between steel and surface, but in the thicker shell areas the steel

Fig. 4. Skin of the form system was 1-in. boards warped into place over curved wooden ribs.

is separated into mats of two layers, one ring and one meridional each, which are pulled apart to keep the outer steel just 1 in. from the surface. Use of the small bars makes even distribution of the steel possible, which is important to insure safety against influence of volume changes of the concrete, due to shrinkage, temperature and plastic flow.

Construction procedure

The formwork for the shell domes was simple. Posts were arranged about 12 ft. center to center over which timber caps were placed to form horizontal rings. These timber rings formed the base for the meridional joists over which 1-in. wood sheeting was applied. Exterior or top forms were necessary only in the lower 12 ft. of the shell. Concrete was hoisted in a bottom-dump bucket and distributed on circular runways in buggies and wheelbarrows. Naturally, great care was taken in spading the concrete. In the flatter sections of the domes, a 4-in. slump concrete was used for the lower layer, immediately followed with an upper layer of 2-in. slump concrete. Very satisfactory bottom surfaces were obtained by this procedure. Finishing was done by screeding with curved boards moved along horizontal screed strips, as in any other slab construction, and by a belt handled by two men.

Decentering was planned carefully, for in these domes where the shell thickness is only 1/500 of the span, the transfer of weight of the shell from the timber supports to wall support had to be done with care. The total downward movement at the lantern ring was only about 1/15,000 of the span.

The outside of the shell was first painted with two coats of emulsified asphalt followed by one coat of aluminum paint.

Direction

The sewage plant is a PWA project for the town of Hibbing. Charles Foster, Duluth, Minn., was consulting engineer on the project, and J. C. Taylor was architect. W. C. Jones was resident engineer-inspector for PWA, James H. Rough is village engineer, and Roy C. Pascoe was project engineer. E. W. Coons Co., Inc., was general contractor on the structure.

Fig. 5. Finishing of the dome concrete was by screeds riding on guides, same as for flat slabs.

The domes were designed by the Roberts & Schaefer Co., Chicago, under the Z.D. system of concrete shell. The cost of the shells, including the asphalt and aluminum paint, was approximately 75 c. per sq.ft. of covered area.

Covered Filters for Efficiency

CHARLES FOSTER

Consulting Engineer, Duluth, Minn.

SANITARY ENGINEERS who have read the foregoing article on the design and construction features of the elliptical dome covers used at the Hibbing, Minn., sewage disposal plant, quite naturally will be interested to know why the trickling filters were inclosed. The reasons are these:

Experience has shown that if the filter beds are inclosed practically no ice will form on the filter at the low temperatures which are frequently met with in this latitude. If ice formation can be prevented, a high efficiency is obtained during the period of low temperature; this, of course, gives a greater overall plant efficiency record for the year.

Furthermore, the cover is a safeguard during periods of snow accompanied by a high wind. With snow piled on the bed and a prolonged spell of sub-zero weather, large masses of ice would be formed which would interfere with the rotating spray mechanism.

At the Hibbing plant the filter inclosures, together with the underground drainage system has been so designed that forced aeration could be applied with minor alterations to the structure, should this practice be found advisable at a later date.

The Hibbing plant, which was designed by the writer, has a treatment capacity of 2 mgd.

New and Unusual Upper Deck For Chicago's Michigan Ave. Bridge

Contents in Brief—The 20-year-old Michigan Ave. bascule bridge in Chicago, one of the most heavily traveled in the world, has a new upper deck which replaces the rubber block paving laid 15 years ago as an innovation in bridge surfacing. Asphalt plank is the new wearing surface, laid on timber subflooring, except at the end zones, where a novel cast iron grid filled with concrete is used because of excessive wear. Extruded aluminum shapes form the new center and side curbs.

FIFTEEN YEARS ago this fall a rubber block paving was placed on the upper deck of the famous bridge that carries Michigan Ave. over the Chicago River in Chicago. This was an innovation in bridge paving, showing great promise. However, the rubber block never proved entirely satisfactory under a steady traffic of some 50,000 vehicles per day, and frequently repairs, replacements and patching with asphalt were necessary. Now the rubber is being entirely replaced with asphalt plank on both roadway and walk. In the end zones of each leaf, where roadway wear is excessive because of stopping of heavy buses by traffic lights, the surface will be a cast iron grid of unusual design, filled with concrete. The bridge engineers have also worked out a new design of center and side curbs using extruded aluminum shapes to get the desired contour of curb, as well as to minimize weight of additions made to the bascule span.

The bridge, built about 20 years ago, is a double-deck, double-leaf bascule structure of 220-ft. clear span. Only the top deck, which carries two 27-ft. roadways 336 ft. long, separated by a 6-ft. center curb, is being replaced at present, as the lower deck was repaved ten years ago. The top deck also has a sidewalk 14 ft. 4 in. wide on each side.

Construction procedure

Only one roadway was replaced at a time. In the initial operation, southbound traffic was diverted to other bridges to release the westerly span.

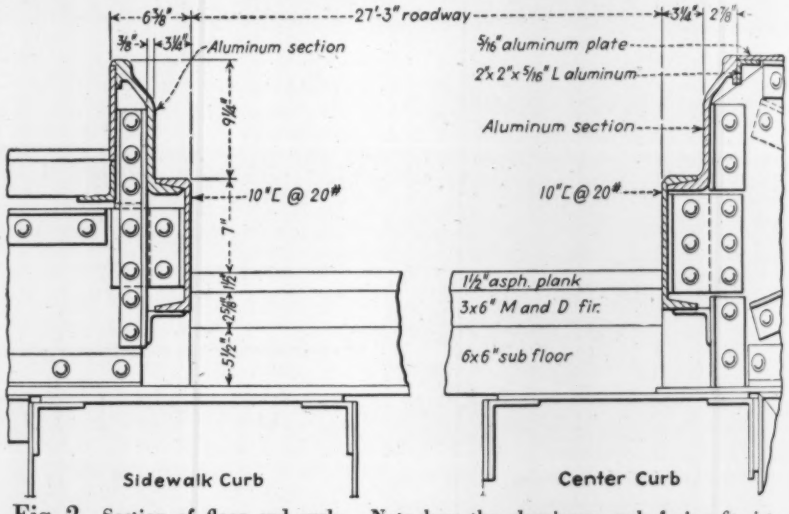


Fig. 2. Section of floor and curbs. Note how the aluminum curb facing fits into the steel channel.

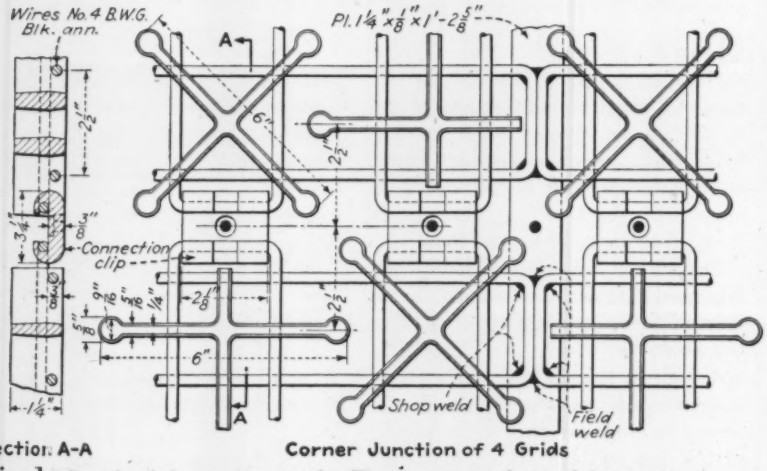


Fig. 1. Details of the cast iron grids. The crosses are designed for maximum wear and stopping resistance. Chicagoans will find easy stopping here a novelty, for they have slid to a stop over rubber pavement at these spots for years.

Construction was hampered by frequent bridge openings for river traffic. Keeping the bridge free to open required temporary counterweights, which, with all loose materials on the deck, had to be kept piled against temporary bulkheads so they would ride the span when it was opened: workmen hurriedly carried tools and supplies off the bridge when the opening signal was sounded.

The first step in reconstruction was the stripping off of the rubber block and asphalt patches with pneumatic spades and chisels. This left the nails, which fastened the blocks, protruding and they had to be laboriously pulled out with claw bars and tongs. Next the 3-in. timber subfloor was torn out, exposing the subdeck of

6x12-in. creosoted pine. This deck was not removed, but was entirely rebolted to the steelwork by bolts with special malleable iron washers, which set into recesses routed out with a pneumatic router. The subdeck was thoroughly recalked—it has leaked for years—and then covered with asphalt-mopped roofing paper.

A new subfloor of 3 x 6-in. dressed and matched salt-treated fir was then spiked to the subdeck. The spikes were placed and started by hand but were driven down by pneumatic hammers. A mopping of hot asphalt was placed on the subfloor and mineral-surface asphalt planks, 1½ in. thick and 12 x 24 in. in size were then spiked to the subfloor to complete the surfacing. The sidewalk timber framing was also replaced by 2½-in. fir subflooring and resurfaced with ¾-in. plain asphalt planks 8 in. x 6 ft. laid in herringbone pattern.

From the center of trunnion to the back end of each leaf (35½ ft., the wearing surface is a special cast-iron grid, as shown in Fig. 3. The grid is built up of cast-iron crosses cast around ¼-in. rod reinforcing, all welded to steel strips to form panels

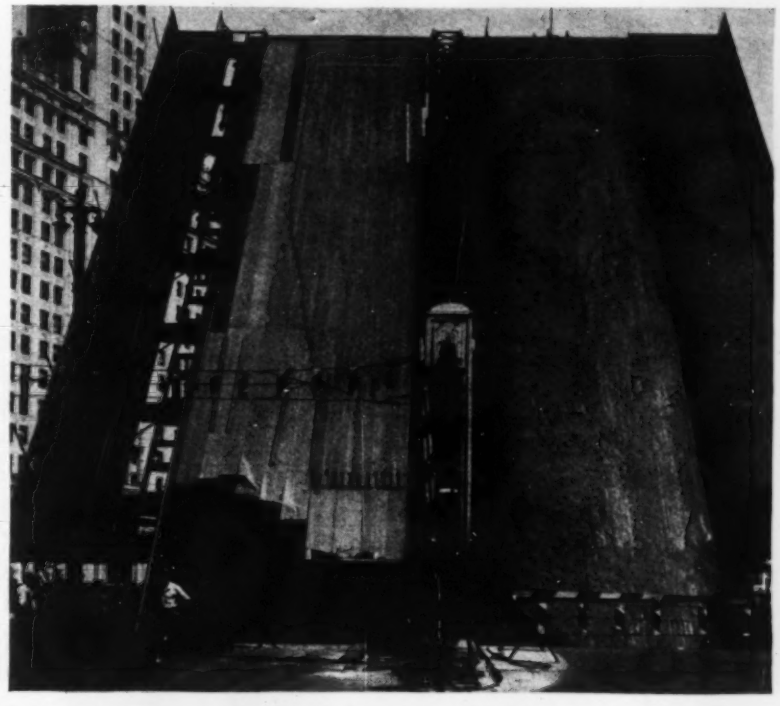


Fig. 4. Resurfacing the top deck of the Michigan Ave. Bridge in Chicago halts while a boat passes through. This view shows the two layers of timber flooring on the left (southbound) roadway, later covered with asphalt plank. The bad condition of the old rubber block paving is seen on the right roadway.

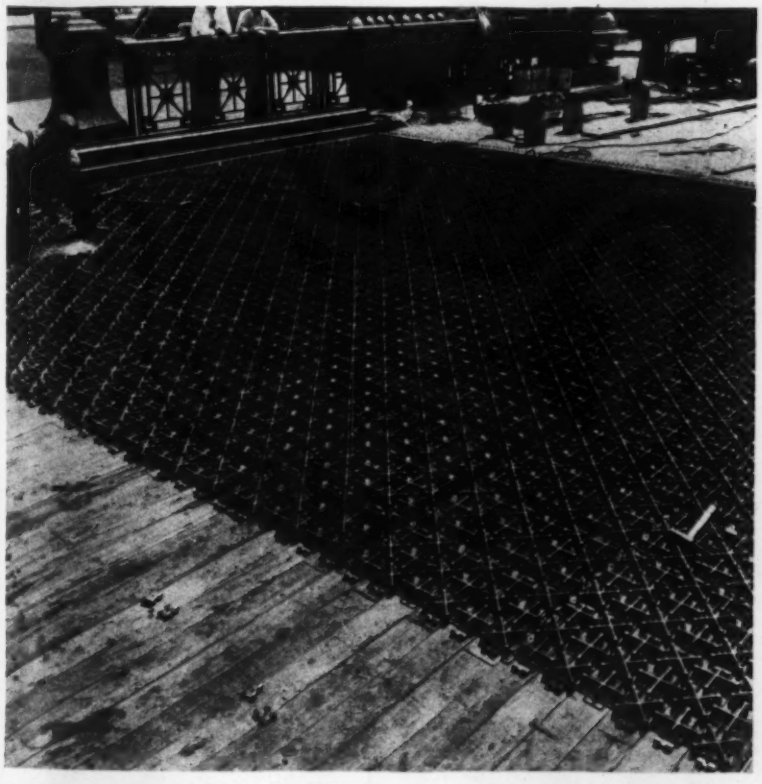


Fig. 3. Cast iron grids, later filled with concrete, were placed on the outer ends of the bascule span where surface wear is excessive because of traffic light stops. The iron crosses are cast around heavy wire loops, are welded to steel strips to form panels, and the panels are hooked together with iron clips. The grids are spiked to the wood floor.

15 x 30 in. The panels are so constructed as to retain a flexibility that permits the grid to follow any unevenness in the floor and thus obtain a solid bearing. End connections of adjacent panels are field welds to the steel strips; side connections are special hooked cast lugs. The panels are spiked to the timber deck through holes in the lugs and the steel strips. The grids, 1¼ in. deep, are filled with concrete.

The old low timber curbs at both center and side of roadways had never been considered as adequate or safe by the city engineers. These were therefore replaced by structural curbs made up of steel framing and extruded aluminum section and steel channel facing, as shown in Fig. 2. The aluminum shapes are to provide a curb contour designed to stop a car's tires without damage to hub caps or fenders. Curtailing of rain splash from automobiles onto pedestrians is also accomplished by the added height of curb.

The work was carried out by city bridge maintenance forces under the general direction of Loran D. Gayton, city engineer, and Thomas G. Pihfeldt, engineer of bridges. O. W. Hansen, engineer of bridge maintenance, was in direct charge.

San Gabriel Dam Outlet Tunnel Enlarged for Valve Chamber

PAUL BAUMANN
Senior Assistant Chief Engineer, Los Angeles Flood Control District

Contents in Brief—Valve chamber for control works in the outlet tunnel of San Gabriel Dam No. 1 formed by progressively cutting away the lining and outer rock. Anchor rings for tunnel plug cut at the same time.

COMPLETION of the overpour spillway on San Gabriel Dam No. 1, of the Los Angeles County Flood Control district, afforded protection for the dam against flash floods and made it possible to take the bypass tunnel out of service, thus permitting construction of the concrete plug and the control works. Preparing for the plug was a simple matter of providing anchorage. The control works involved more complex construction because a spherical chamber was required to provide space for the large valves which it was desired to locate at the upper end of the outlet pipes. Methods used in making the spherical excavation are described in the following.

The diversion tunnel has a diameter of 30 ft. inside the concrete lining. This is more than adequate for the four steel pipe lines required in control but not enough for the control mechanisms of valves on the large pipes. Hence, in addition to cutting rings in the existing concrete lining for anchoring the concrete plug, the tunnel was enlarged to a diameter of about 60 ft. to afford space for valves just downstream from the plug.

Excavation of the valve chamber was begun from a jumbo which enabled workmen to start at the crown of the arch, driving a vertical shaft upward through the lining and the rock behind it. At first only sufficient lining was removed to provide access to the space above.

As the opening into the tunnel was enlarged and more working space was afforded it was found possible to break out some of the material in larger fragments with the use of explosives and gads. None of the rock was considered solid enough to stand safely without timbering as it was not difficult to break it down with moderate powder charges.

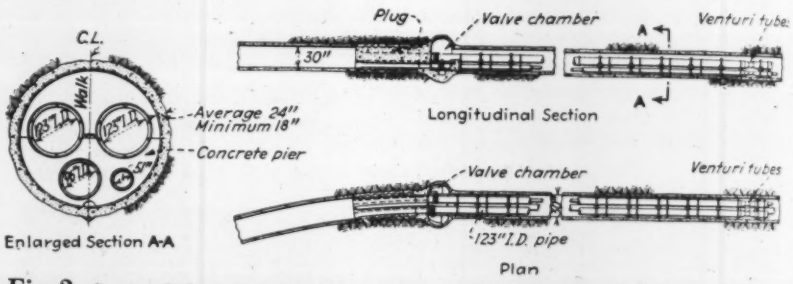


Fig. 2. Sectional drawings of outlet tunnel at and near the control chamber.

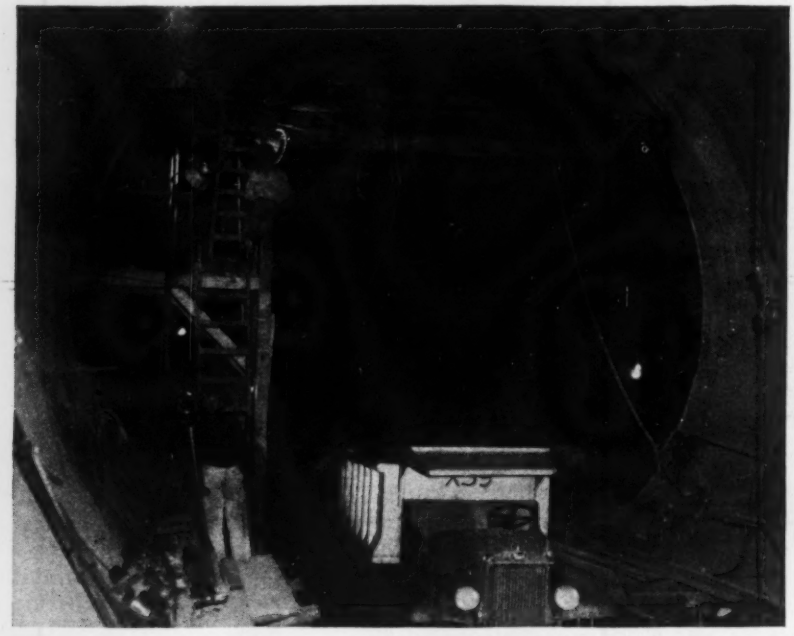


Fig. 1. Interior of the outlet tunnel. In background note recesses cut in existing concrete lining as anchorage for the concrete plug. The dark area indicates excavation for the spherical control chamber.

The shaft driven upward at the outset was then widened in an up- and downstream direction until the resulting cut formed a vertical section of the proposed dome. In this cut timber arches were set resting on rock ledges at the spring line. As the cut was widened on both sides additional arches were set in planes radial to the tunnel axis. This continued until 18 arches had been placed, occupying 120 deg. of arc measured normal to the tunnel axis. Sufficient lagging was put in to give the rock adequate support. A coating of shotcrete was then placed between the arches to prevent falling rock or air slacking. Steel tierods also were used to support the arches laterally as they were placed symmetrically, starting at the top, on opposite sides of the vertical plane through the tunnel axis.

With the roof of the dome supported in this manner the excava-

tion was extended downward and completed at the invert. The existing concrete lining was removed with the rock. As soon as excavation reached the low point, concrete placement commenced in the bottom and proceeded upward in 5-ft. lifts. Meantime, seepage water was collected in a sump to be made a part of the permanent installation but which was temporarily carried below the final grade. Concrete forms were shaped like parts of the hull of a ship except that the ribs were horizontal and the sheeting vertical. Heavy reinforcing was put in the forms.

Pneumatic placement of all concrete helped speed the work, particularly at the top of plug and dome. Thickness of shotcrete in the dome varies from 2½ ft. at the crown to 4½ ft. at the spring line. Maximum thickness from inner face of the lining to the rock is about 6½ ft.

The concrete plug

Preparation for the concrete plug, carried on at the same time as excavation of the valve chamber, consisted of drilling and breaking out concrete in the existing lining to form anchor rings about 12 in. deep and 4 ft. wide. The plug occupies about 100 ft. of the tunnel length, filling the space around the four pipes which were all fastened in place before the plug concrete was poured.

The dome is supported on the concrete plug on the upstream side of the valve chamber. On the downstream side, where the tunnel breaks the continuity of the dome ring, support for concentrated load was provided by cutting a 6-in. recess 72 in. wide into the existing lining and placing therein heavy steel reinforcing imbedded in shotcrete.

The work was under the general direction of C. H. Howell, then chief engineer, Los Angeles County Flood Control District; E. R. Stuver and R. D. Reeve were, respectively, resident engineer and assistant resident engineer. The contract was held by the West Slope Construction Co., W. B. Arndt, superintendent.

Traffic Control Booth For Golden Gate Bridge

NEW RULES for commutation tickets and need for better supervision of toll lanes resulted in the recent construction of a traffic control building on the toll plaza of the Golden Gate Bridge. The new building is of steel and concrete, 22x6 ft. in plan and is located on the longitudinal center line of the plaza, 60 ft. back from the nearest toll booth. It contains all nerve centers of traffic control; a master station for a two-way intercommunicating loud speaker system by which the toll sergeant can communicate with fire and tow-service departments, the toll captain's office and can talk with each toll-collector or listen to conversations between collectors and patrons. A microphone connected to loud speakers at each end of the plaza enables the toll sergeant to direct traffic for 500 ft. or more on either side of the plaza.

The lower part of the building is built of reinforced concrete with heavy concrete nosings designed to resist the impact of automobiles out of control; the upper half of the building is glass in steel sash, affording full vision in all directions. The structure occupies no more space than a toll booth and is so located that patrons in any of the 14 lanes can stop alongside to purchase commutation tickets. Such tickets, the management recently decided, must be signed and must have license numbers written thereon, thus making better facilities desirable.

In designing this structure it was realized that with walls of ordinary glass, on clear days the interior temperature resulting from the sun's rays would make the booth practically uninhabitable. On the basis of claims that the interior would be 10 to 20 deg. cooler if the sun's rays had to go through Solex plate glass, that material was used exclusively. It is light green in cast, is expected to transmit less than 43 per cent of the total solar heat, less than 28 per cent of the sun's infra-red rays, and essentially no ultra-violet rays. The roof is of sheet metal over a heat-insulating ceiling. The floor is linoleum on plywood subfloor. Total cost, including telephones, loud speakers, and all control equipment and furnishings was about $5,500.

The building was designed by Vincent Raney, architect, under direction of Russell G. Cone, engineer, Golden Gate Bridge and Highway District, San Francisco.

New traffic control building at the Golden Gate bridge toll plaza has comprehensive control and communication systems, glass walls that exclude solar heat and concrete buffers to fend off wild drivers.

Eliminating Gas Explosion Hazards In a Sewage Disposal Plant

***Contents in Brief**—The Ohio conference on sewage treatment emphasized safety features of the Dayton plant reconstruction and discussed the Ohio River pollution survey, activated sludge operation and fish pond experiences. The following notes were prepared for Engineering News-Record by Paul Hansen, consulting engineer, Chicago.*

LESSONS LEARNED from the Dayton, Ohio, sewage disposal plant gas explosion last year (*ENR*, Nov. 17, 1938, p. 599 and Dec. 1, 1938, p. 688, 695 and 696) were incorporated in reconstruction of the Imhoff tanks, delegates to the annual Ohio Conference on Sewage Treatment were told. The meeting, held in Toledo on Oct. 5-6, included papers on the Ohio River pollution survey, experiences with fish ponds using plant effluent, and operating results achieved at Chicago's North Side activated sludge works.

Eliminating gas hazards

In reconstructing the Imhoff tanks at Dayton after the explosion, W. B. Nagel, operator of the plant, stated that these three principles guided the design: (1) all gas lines were isolated; (2) all points where ignition could take place, such as electric switches, were insulated; and (3) provisions were made for the quick escape of gas.

The floor over the gallery of the tanks was constructed with many open spaces covered by gratings. This floor was not poured as a continuous slab but was made of relatively small slabs of concrete about 3 x 8 ft. in size; the joints were filled with bituminous material so that in case of a heavy explosion individual slabs would be dislodged without destroying the entire floor. The piping in the gallery is supported from the floor underneath instead of being suspended from the roof as was the practice heretofore. No open flames, such as in connection with furnaces for heating coils, are permitted in the sludge control building. The doors on this building, which is about 150 ft. distant from the tanks and galleries, are made to open outward, and a number of additional openings are maintained with direct access to the outside atmosphere.

The operating personnel has been instructed in precautions against explosions, and no one is permitted to smoke. Instructions to employees emphasize that care must be used in shutting down sludge ejectors so that water hammer will not break pipes and permit the escape of gas; frequent flushing of the collecting manifold in the digestion tanks also is called for. The sewers of the city will be supervised to prevent entrance of inflammable liquids, such as gasoline and naphtha.

Mr. Nagel referred to the report of the *Committee on Gas Hazards* of the New Jersey Sewage Works Association [John Downs, Plainfield, is secretary] as representing a good inventory of the hazards at disposal plants.

Ohio River survey

In a paper on the Ohio River pollution survey, H. W. Streeter and E. S. Tisdale of the U. S. Public Health Service, outlined the organization and equipment for the work, and the progress that had been made. The survey is under the control of the Ohio River Board consisting of Gen. M. C. Taylor of the Army Engineers, Abel Wolman of the National Resources Committee and R. E. Tarbett of the U. S. Public Health Service. In this study on the Ohio River and its tributaries, attention is being given to sources of pollution and water supply conditions.

The Army Engineers are making stream measurements, and in this connection are utilizing the services of the U. S. Geological Survey. Collection of field information and samples is being handled by Mr. Tisdale, while the laboratory work is being done under the direction of Mr. Streeter. The personnel and laboratory facilities of various state departments of health are utilized as far as possible, and in addition a central laboratory has been established in quarters of the U. S. Public Health Service at Cincinnati.

Two floating laboratories are also employed on the Ohio River and navigable tributaries. These laboratories are converted "quarters boats" formerly used by the Army Engineers. The lower deck is devoted to laboratories and the upper deck is used for living quarters. Accompanying each houseboat is a motor launch for collecting special samples. Points that cannot be reached by boat are served by automobile trailer laboratories. The trailers are set up at central localities for periods of about two weeks, during which the tow car is employed in gathering the samples within a 50-mile radius.

One division of the survey has been assigned to the study of epidemics attributable to unsanitary conditions; a special investigation is to be made of gastro-enteric cases that have occurred from time to time in epidemic proportions at various points within the drainage area.

The Ohio River watershed has been divided into three sections for the purposes of this survey. The middle section is being taken first for intensive study including collection of samples and their analyses. The upper third above the Kanawha River will be taken next. The last section to be studied will be the lower portion, which includes the drainage area below the mouth of the Big Miami River. The program will take three years for completion, on the basis of one year to be devoted to each section. The survey will be directed towards an evaluation of the uses of the waters of the Ohio River Valley for drinking purposes, sewage dis-

posal and industrial purposes, and recreational pursuits.

In connection with the studies of industrial waste, guides or manuals on the handling of various types of industrial wastes have been developed, and these are available from the U. S. Public Health Service. (Address E. S. Tisdale at Cincinnati.)

Effluent for fish ponds

A fish pond filled with sewage plant effluent is successfully operated at the Lima sewage disposal plant, according to C. W. Prentice, assistant superintendent. The pond is fed by a small stream of effluent from the activated-sludge plant, the effluent being delivered to a point several feet above the pond level and permitted to cascade over a step aerator. The pond was stocked originally with 18 goldfish. Seven died due to injury in transportation but the survivors thrived and in the following spring they had increased their number to 500 or 600. Five varieties of small fish from a neighboring stream were also added and these survived.

For comparison, some small goldfish were placed in an aquarium fed with city water. They were given as much food as they would consume. However, the fish maintained in the sewage effluent pool grew 10 to 15 per cent larger than those in the aquarium in a single season. The pool is planted with water lilies and other plants, is suitably landscaped and attracts a great deal of attention. The psychological effect on the public is good as the average citizen thinks of stream pollution in terms of fish destruction.

Activated sludge operation

Operating experiences at the Chicago Northside activated sludge treatment plant serving about 1,300,000 people were described by John R. Palmer, superintendent. The aeration tanks are 440 ft. long by 34 ft. wide with a center wall dividing each tank into two channels, each 16 ft. wide. The plant was designed to use one cubic foot of air per gallon of sewage, and in the earlier years of operation this amount of air was used, resulting in substantial nitrification of the effluent. At the present time only 0.35 cu.ft. of air per gallon is used; this is not sufficient to produce nitrification.

Variables affecting control of the activated sludge process were stated to be: concentration of solids and mixed liquor; amount of air used per gallon; aeration period; secondary settling period; and the rate of return sludge.

Formerly the amount of solids in the mixed liquor was kept at from 3,500 to 4,000 ppm. However, when the quantity of air was reduced it was found necessary to reduce this concentration about 2,300 ppm for satisfactory results. The quantity of solids is controlled by the amount of waste sludge removed from the system. The concentration varies and may become as high as 3,500 parts per million during storm periods. However, sufficient dissolved oxygen is brought in with the stormwater so that it is not necessary to increase the quantity of air during the short period of increased solids concentration. The rate of aeration is regulated to maintain about 2 ppm dissolved oxygen in the effluent of the aeration tanks.

The rate of sludge return is regulated to prevent a deep blanket of sludge in the final settling tank. In each battery of these tanks small air lifts have been installed, operating from three different levels by which the operators may observe the depth of the sludge. Observations are made every four hours to insure proper operation.

A "sludge index" or the volume occupied by one gram of sludge after 30 minutes of settling is used as a guide to the quality of sludge and plant control. Some trouble from bulking is experienced at the plant because of the low inorganic content of the sludge. At the nearby Calumet plant, which receives considerable industrial waste, the sludge index is approximately 44 with an ash content of 46.5 per cent; at the Northside plant which receives practically no industrial waste, the sludge index is about 73, with an ash content of 31.8 per cent.

Sewer Control By Municipal Authorities

CONTROL of public sewers is necessary if proper service is to be obtained, according to *The Digester*, bulletin of the Illinois State Department of Public Health. As examples: In Chicago, three persons were injured by a sewer explosion; Waukegan has been concerned over the presence of explosive substances in the sewers; Sycamore has passed an ordinance prohibiting the discharge of acids and oils and controlling the discharge of industrial wastes into the sewers; Morris has moved to abolish privies in all sewered areas, and at Salem, Rochelle, McLeansboro and Edwardsville there is considerable difficulty due to filling-station oil discharged to the sewers.

It is pointed out that city councils and village boards have full authority to regulate and control the proper usage of all sewers and drains in municipalities, while sanitary district trustees have similar authority over laterals and intercepting sewers under their jurisdiction. But too often it is the case that the problem is met merely by the passage of an ordinance, with no particular effort made towards its enforcement. Gasoline leakage and explosive substances from cleaning establishments or other industries may cause serious explosions. Uncontrolled dumping of wastes, such as feathers, unground garbage and spent grain, may cause clogging of sewers.

Lack of inspection of new connections may result in admittance of surface water from downspouts to sanitary sewers, causing overloading of the system and basement flooding. Similar lack of inspection may give rise to nuisances at storm sewer outlets where sanitary sewage and basement drainage is improperly discharged into them. Admission of certain acid wastes from industries may cause disintegration of sewer pipe and so necessitate costly replacement. All these mistreatments can be eliminated by proper application of the authority which has been delegated to municipal officials for safeguarding life and property.

A Stress-Cured Concrete Pavement

F. W. Russe, Jr.

Research Development Co., St. Louis, Mo.

***Contents in Brief**—Pressure cells in joints place concrete pavement under endwise compression. Data on compressive strength of green concrete. Method of construction described. Purpose of longitudinal compression.*

Two 940-ft. lengths of pavement in a 1½-mi. road constructed last summer near Martinsburg, Mo., were cured with the slabs under endwise compression. Shortly after initial set of the concrete, each joint form was removed and a hose was pressed into the open joint for its full depth and length and then inflated. This procedure put the slabs under longitudinal pressure which was maintained at increasing intensities for about five days. Then the hose was pulled out of each joint and the joints were filled with asphalt. All work was carried out by the regular contractor, Koss Construction Co., Des Moines, Iowa, which used pressure equipment developed by the Research Development Co., St. Louis, Mo., for the stress-cured sections and constructed the remainder of the road by the usual methods.

The purpose of longitudinal compression used on this experimental road section is to facilitate the natural shrinkage of hardening concrete and to place all parts of the mass under compression so that tension stresses and resulting cracking of the concrete are eliminated during the hardening period. At mature age, the anticipated tension stresses should safely be carried by the concrete.

Except for joint spacing, which was varied for comparative study, the experimental sections, one at each end, are of the same design as the remainder of the pavement. This is a 9:7:9 pavement 20 ft. wide of 1:2.05:3.95 concrete by weight. An average of 5¾ gal. of water per sack of cement was used and the mix had a 1½-in. slump. The contractor used a 34E dual drum paver, a finishing machine with a tubular vibrator and a mechanical longitudinal float. All concrete was laid on subgrade paper and was cured for 72 hr. with cotton mats.

Each pressure section contained twelve joints dividing the pavement into slabs of varying length from 40 to 100 ft. so that information could be had of the influence of slab length. The joints were formed ¾ in. wide using a solid plate flanked by two galvanized strips. Load-transfer was carried below the open joint by Translode angles with a special base-sleeve so that the joint was free to spread under pressure. The concrete was vibrated on each side of the joint form and after final screeding the stakes that pinned the form in place were pulled. When the concrete was 2 hr. old the forms were pulled and the joint was edged and cleaned ready for the hose to be inserted and pressure applied.

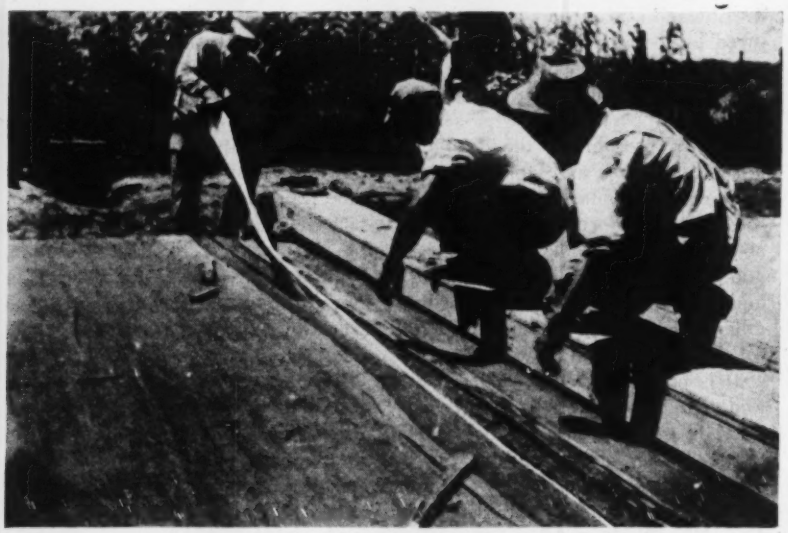


Fig. 1. Rubber pressure cell being installed in a transverse joint to put endwise pressure on pavement slabs by inflation.

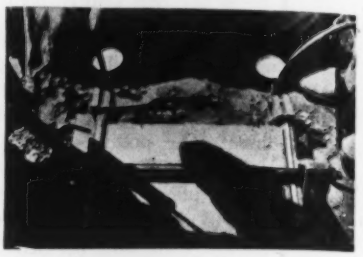


Fig. 2. Small test slabs molded simultaneously with the pavement slab are crushed to determine safe pressure to put on cells in the pavement joints.

To determine the safe age at which to apply pressure, tests were made of the concrete at ages from 4 to 8 hr. Test slabs 7x9x14 in. were molded alongside the pavement in steel forms on subgrade paper of the same concrete as the adjacent pavement. Hand vibrators applied to the steel forms settled and compacted the concrete and it was cured under wet cotton mats. The forms were removed and the small slabs were tested in place by inflating short sections of hose placed on opposite sides and confined by the end plates of a steel yoke as shown by Fig. 2. As of interest in showing concrete strengths at very early ages the test results are given by Fig. 3. The effect of temperatures of construction on strength will be noted.

As stated, pressure was applied to the pavement slabs by inserting specially equipped lengths of hose in the joints and inflating them. These pressure cells are made of rubber-lined cotton fabric and when collapsed for insertion, Fig. 1, are 7 or 8 in. deep, ½ to ⅝ in. thick and somewhat longer than the pavement width. Each end has a special seal and steel fitting and at one end are intake and exhaust valves and a pressure gage. To protect the corners of the slab and keep the volume of the pressure cell small, the overlapping ends of the cell are confined by bolted clamps (Fig. 4) close to the pavement. The cell is inflated by a special high-pressure hand pump.

In the actual operation, which differed on the two sections, after the strength of the concrete had been determined at a joint the cell was inflated to give a pressure of half the crushing strength. Thereafter the pressure was increased hourly until a maximum of 100 lb. per sq.in. was obtained which was considered enough to overcome subgrade friction in 100-ft. slabs. In a measure the application of pressure on the first 940-ft. section was experimental. The thought was to vary the pressure somewhat in proportion to the length of slab; thus on the third day the pressures were 170 lb. for the 100-ft. slabs and 120 lb. for the 40-ft. slabs. This did not work as the cells with higher pressure shoved the slabs toward the joints with lower pressure. On this section the pressure was removed gradually on the fifth day when beam tests showed a modulus of rupture of 750 lb.

In the second section equal pressure was applied regardless of slab length, as soon as the younger joints had been brought up to 100-lb. pressure. Paving was started at 6 a.m. and was completed in 5½ hr.; at 11 p.m. the pressures were 130 lb. and at 2 a.m. 140 lb. On the second day pressures were raised to 160 lb. and kept about at that point until the fourth day when all were reduced by gradual deflation.

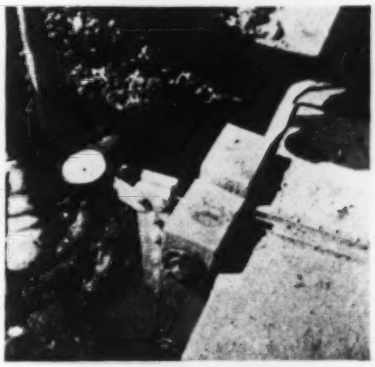


Fig. 4. Bolted clamps at pavement edges confine pressure cells at the slab ends; gage records actual pressure in inflated cells.

Fig. 5. After pressure cells are removed from the widened joints, they are filled with asphalt.

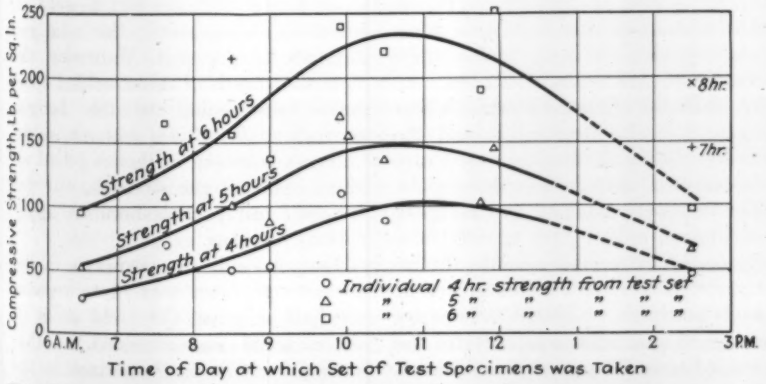


Fig. 3. Graph of results obtained in actual construction from compressive strength tests of concrete from four to eight hours old.

Stress-curring is a mechanical means of nullifying the harmful effects of large daily temperature variations usually encountered during construction weather; the greater compressive strength of fresh concrete is used, instead of allowing the slabs to go into tension by contracting over the subgrade. During construction of these experimental sections, compression was successfully maintained throughout the treated slabs and it is expected that one of the major causes of cracking has thus been eliminated. The pavement is still too young to enable conclusions to be drawn, but the engineers of the Missouri highway department have conducted many tests and are keeping close watch of service behavior to be reported later.

. . .

Rust Improves Bond of Reinforcing Bars

Bond resistance of deformed steel bars that have been exposed to normal rusting conditions is considerably greater than that for non-rusted mill-surfaced bars, according to the general conclusions of a report to the Concrete Reinforcing Steel Institute by A. E. Lindau, chairman of the engineering practice committee. Previous experiments had developed similar results with plain bars, but in the present case it was desired to determine at what stage, if any, there may be an increase or decrease in bond resistance. Test bars were exposed both indoors and outdoors for a maximum period of 15 months.

At a slip of 0.001 in. there is obtained 70 to 75 per cent of the maximum bond resistance, and this end slip is considered as the limit of useful bond stress. The general results are summarised as follows: (1) for all sizes of bars the bond resistance is greatly increased after 12 months' exposure; (2) for ⅜-in. to ¾-in. round bars the resistance after such exposure is increased 100 per cent; for larger bars, the resistance remains approximately constant up to and including nine months, but increases considerably with more exposure; (3) in general, outdoor exposure produced greater bond resistance than indoor exposure; (4) bond resistance for 15 months' exposure is about the same as for 12 months, indicating that the resistance levels off at about this exposure.

Arc and Gas Welding Developments

***Contents in Brief**—Among the sixty papers presented at the annual convention of the American Welding Society in Chicago, Oct. 22-29, were about a dozen that had direct application to civil engineering, and those that lend themselves to abstracting are presented here. Weld design, inspection and technique are covered in addition to new developments in the use of the oxyacetylene torch.*

WELDING RED BRASS PIPE

RED BRASS, consisting of 80 to 85 per cent copper and 20 to 15 per cent zinc, is widely used in domestic hot water systems and for rain conductors in buildings, both services in which joints must have unquestionable strength. Early welded brass piping joints, which were made with standard braze welding rods and dry fluxes, had relatively low tensile and ductility values and were particularly lacking in density. Investigation and research directed toward improvement of the braze welding processes disclosed that the difficulties lay not with the various rods but with the fluxes. The result has been the development of a liquid or semi-paste flux which yields welds of the highest physical properties yet obtained and at the same time achieves virtual elimination of fumes during the welding.

The successful application of the new flux requires no radically new welding technique. It is brushed on the base metal and applied to the rods by dipping, providing a more uniform distribution than is possible by dipping the hot rod in a powdered flux. It also yields higher welding speeds in that it reduces the number of round trips to the flux can.

In welding brass a standard braze welding rod is used. The welding tip should be of a somewhat larger size than would be employed on steel pipe of the same weight, due to the greater heat conductivity of the brass. The torch flame is adjusted to a strictly neutral condition. The fluxed, beveled ends are tacked with a sufficient number of tacks about half the thickness of the pipe wall to maintain proper alignment. Welding may be either forehand or backhand as the position of the joint and neighboring obstacles dictates. Usually the forehand technique is preferred on rolling welds and horizontal pipe position welds. The backhand procedure, since it lends itself more readily to the control of the metal, is generally used for vertical pipe positions.

Of special interest is the use of this same flux in welding of galvanized pipe. By coating the pipe for 3 to 4 in. on each side of the weld the galvanizing is preserved intact during the braze welding. The deposited bronze flows up to and overlaps the zinc, producing an assembly that is corrosion resistant.—ARTHUR N. KUGLER, *Air Reduction Sales Co., New York.*

FATIGUE STRENGTH OF WELDS

One of the deterrents to the use of welding in bridge fabrication has been a lack of knowledge of the fatigue strength of welded joints. Realizing this situation the welding research committee of the Engineering Foundation organized a committee to plan and carry out an investigation of fatigue strength. The tests were planned by the committee, of which Jonathan Jones is chairman, and were financed by the Chicago Bridge & Iron Co., the Public Roads Administration, the Bethlehem Steel Co. and the U. S. Navy, and in addition Carnegie-Illinois Steel Corp., Lukenweld, Inc., General Electric X-Ray Corp., Lincoln Electric Co. and the Lasker Boiler & Engineering Corp. contributed materials and services. The tests were made at the University of Illinois, utilizing the two 200,000-lb. machines recently used in the fatigue tests of riveted joints as well as some machines of 50,000-lb. capacity designed and built especially for the welded tests. The specimens, consisting of single-vee butt welds in ⅜-in. structural carbon steel and low alloy (manganese-vanadium) steel plates, were subjected to three relations of minimum to maximum stress: (1) from tension to an equal compression; that is, complete reversal; (2) from zero to tension; (3) from tension to tension one-half as great. The maximum stresses in the stress cycle were chosen to cause failure at 100,000 cycles and at 2,000,000 cycles. The specimens were tested (1) in the as-welded condition; (2) with the welds planed flush with the base plate; (3) after stress relief at 1,200 deg. F. for one hour and cooling in the furnace. The effect of frequent periods of rest upon the fatigue strength of the butt welds in the carbon steel plates was also investigated.

In the as-welded condition, the values of the fatigue strengths for the complete stress reversal cycle were 21,600 lb. per sq.in. for failure at 100,000 cycles and 14,800 lb. per sq.in. for failure at 2,000,000 cycles; for the cycle from zero to tension, strengths were 32,600 lb. (100,000 cycles), and 23,100 lb. (2,000,000 cycles).

For specimens with the welds machined flush with the base plate, fatigue strengths for the stress reversal cycle were 29,400 lb. (100,000 cycles), and 19,800 lb. (2,000,000 cycles); for the zero to tension cycle, fatigue strengths were 47,000 lb. (100,000 cycles) and 30,100 lb. (2,000,000 cycles). That is, removing the stress raiser caused by the change in section at the edge of the weld reinforcing increased the fatigue strength 43 per cent. Moreover, the fatigue strength of these welded specimens was equal to the fatigue strength of the plates without welds.

Stress relieving by heating had no effect upon fatigue strength, nor did frequent rest periods between applications of loads.

For all kinds of specimens in the stress cycle from tension to tension one-half as great, the yield point of the material was exceeded, so that such a cycle is not important to the structural designer.

Fatigue strengths on complete re-

versal of the welded specimens of low alloy steel plate with a static strength of 83,000 lb. per sq.in. were 24,000 lb. per sq.in. (100,000 cycles) and 16,100 lb. (2,000,000 cycles).—W. M. WILSON and A. B. WILDER, *University of Illinois.*

WELDED EXCAVATORS

Construction machinery builders have made rapid strides in introduction of electric arc welding as a production method during the last five years, securing a marked reduction in weight and also in costs. Such excavating machines as shovels, draglines and crawler cranes have particularly benefited from redesign for welding.

In order to take full advantage of the possible economies of the use of arc welding, it is often necessary to change radically the method of framing the welded part as compared with riveted or cast structures. This often results in the use of bent plates which, if properly designed, will reduce the number of welds in a joint. This will not only produce a stronger part but will also reduce the welding time and cost. A shovel boom, for example, may be made of one plate bent longitudinally to form three sides of a box section which, after being stiffened by suitable diaphragms, is closed by the addition of a bottom plate welded with two longitudinal seams. Such a boom built from alloy steel will weigh about 30 per cent less than a mild steel riveted boom made in a box section with corner angles.

Welded dragline and crane booms have been built of all pipe construction. Tubing sections are the most economical in compression due to the symmetry of their sections and it is also possible to make the welded connection between the lateral members and the chords without the use of gusset plates except at the top and bottom where it is necessary to drill holes for pin connections.

Another type of steel boom is one in which the chord members are made of low alloy high tensile steel angles and the lateral members of alloy or carbon steel tubing. The weight of this boom in a 70-ft. length is only about 20 per cent more than a riveted aluminum boom built a few years ago to carry the same loading. This type of boom weighs about 14 per cent less than an alloy steel boom with riveted connections. In its construction, the lateral tube members are welded to the toe of a chord angle. The diagonal diaphragm members are also made of steel tubing and fitted into the inside corners of the chord members.

In substituting welded design for castings for main revolving frames for excavators, important economies have been achieved. Aside from the weight saving, there are savings in machining and assembling costs. Inasmuch as the base plate, side stands and cross separators are all made into one integral piece, there are no machined surfaces needed for joining these parts together. This permits the machining of all bearings and other machinery locating points in one setting and insures greater accuracy and freedom from misalignment of parts due to loosening up of connecting bolts.—H. C. HETTELSATER, *Harnischfeger Corp., Milwaukee.*

FLAME CLEANING OF STEEL

Flaking of mill scale on structural steel, taking the paint with it, has been the cause of much difficulty and heavy maintenance costs. As a remedy, oxyacetylene flame de-scaling and dehydrating processes have been developed which, although new, are at present being subjected to practical tests on steel bridge structures.

The flame cleaning and dehydration process is based upon the theory that heating the steel above 212 deg. F. expands or explodes free semi-tenacious scale and drives off moisture within the scale and rust as well as on the steel surface, which is left in a warmed state conducive to adherence to paint. In practice, flat tips mounted on renewable hard-faced steel wearing skids provide a row of close, small, brushlike flames which are guided across flat surfaces at a forward speed of 10 to 20 lin.ft. per min. and at a flame impingement angle of about 45 deg. For cleaning rivet heads, corners, etc., round tips having hard-faced annular wearing rings are usually substituted. As the flame progresses, differential expansion between the scale and the base metal as well as the formation of steam from the existing moisture causes the scale to loosen and fall in a shower of small flakes and minute particles. There is no dust hazard. The remainder of the scale is loosened to such a degree that a light wire brushing removes it. Sufficient heat remains in the steel for an extended period to allow for painting before reconcentration of moisture occurs on the surface.

Steel fresh from the rolling mill, with little or no weather exposure, will seldom provide more than a 10 to 15 per cent scale lift whereas steel exposed for several months to the air may provide for a scale lift of 50 to 60 per cent. The scale which will not lift, either with the flame or the wire brushing, is definitely tight and can be used as a paint surface provided the moisture is driven off.

Recent experimentation with the process for paint burning and surface conditioning of old steel structures has also met with encouraging success.—J. G. MAGRATH, *Air Reduction Sales Co., New York.*

FLAME TREATING

Flame treating includes flame hardening, flame softening, and flame strengthening, listed in the order of their development. Flame hardening as a heat treating process has been defined as a surface hardening of parts made of quench-hardenable material accomplished by rapid heating of the region to be hardened with the oxyacetylene flame and by subsequent cooling by the application of a suitable quenching jet. There is practically no limit to the type of heating heads which may be developed to meet specific needs.

Flame softening is diametrically opposed to the basic demands of the flame hardening process as its purpose is to soften the material to permit drilling, tapping, or machining. It may be used for the local softening or refining of finished weld passes or the annealing of sheared edges. It has also proved useful in connection with the flame-cutting of high tensile structural steels, overcoming a tendency to toughness, lack of ductility and machinability. There are three methods of using flame softening heads for the removal of hardness from cut surfaces: (1) A single heating head may be applied to the top of the plate which is being flame-cut; (2) there may be simultaneous application of heat from both the top and bottom of the plate; or (3) the softening flame may be applied directly to the cut surface immediately after the cut has been completed. By employing one of the foregoing flame softening processes it is possible to flame-cut materials which otherwise would require expensive machining.

Flame strengthening is the newest and least known of flame treating processes. It is self-defining by name, and is practically identical with the flame hardening treatment. Its intent is to strengthen highly stressed parts locally in the regions of excessive concentration of stress, for example, at abrupt changes of section. Laboratory investigations indicate that fatigue failure may be greatly reduced by the use of flame strengthening.—J. H. ZIMMERMAN, *Linde Air Products Co., New York.*

HARD FACING BY WELDING

The use of welding to apply a hard metal to the wearing surface of a softer metal is being widely practiced. The available hard facing materials of commercial manufacture may be classified in one of three groups: ferrous alloys, non-ferrous alloys and diamond substitutes. In the ferrous alloy group are rods having an iron base alloyed with chromium, manganese, molybdenum, nickel and silicon. The non-ferrous alloy rods are alloys of chromium, tungsten, cobalt and molybdenum. The hardness of both the ferrous and non-ferrous alloy groups is about the same at room temperatures, namely, from 414 to 653 Brinell. In the diamond substitute group are the carbides of tungsten and tantalum and the borides of chromium, which are the hardest materials available. Since this group cannot be applied by self-fusion but must be bonded to the base with some lower melting alloy, it is subdivided into two classifications: the rod form, in which the diamond substitute particles are uniformly distributed in a cast alloy rod and the insert or powdered form.

Ferrous alloy rod deposits may be either of martensitic or austenitic structure while the deposits of the non-ferrous alloy rods are always martensitic. Martensitic deposits exhibit their full hardness in their initial deposited state whereas austenitic deposits are relatively soft as deposited but have the property of hardening at the surface when deformation takes place in cold working. The deposits of the diamond substitute group consist primarily of sharp irregular shaped carbide or boride particles which are extremely martensitic and become firmly embedded in a strong alloy base metal of austenitic characteristics, so that these deposits have the good qualities of both of these types of metallurgical structure without their individual deficiencies.

All types may be applied by either the electric arc or oxyacetylene welding processes, although the latter is usually preferred.

In selecting the right type of rod, several considerations need to be taken into account. If the hardest possible deposit is desired a material of the diamond substitute group should be selected. These are, on the other hand, the most expensive. The outstanding quality of the ferrous alloy deposits is their ability to resist abrasion and deformation, but they have poor corrosion resistance. On the other hand, the austenitic deposits of rods of this group, because of their work-hardening qualities, are best for resisting impact.

The materials of the non-ferrous alloy group are best for producing thin and smooth deposits capable of resisting corrosion. They are also highly abrasion-resistant, particularly at high temperatures.

The best results will be obtained if the melting point of the hard facing material is slightly below that of the base metal and if the coefficients of expansion of the hard facing material and the base metal are approximately the same. Rarely, if ever, should a hard facing deposit be over ¼ in. thick. The usual practice is to apply the hard facing material no thicker than it can be deposited in a single pass, since multiple passes tend to reduce the hardness.—T. B. JEFFERSON, *Corps of Engineers, Washington, D. C.*

TESTING BY COLD ROLLING

In an attempt to develop a more drastic test of welds than the usual tensile, free bend and nick-break tests and at the same time to measure qualitatively any locked-up stresses in the immediate vicinity of the weld, the authors have experimented with a cold-rolling technique. The test consists of taking strips 1½ in. wide of vee or square butt-welded plates up to ½ in. in thickness and passing them through a set of flat two-high rolls of hardened steel. Rolling is transverse to the direction of welding, and all overlays are ground flush with the plate surfaces before rolling. A reduction of 0.010 in. in thickness per pass is considered as a standard, and from 25 to 40 passes are required. The particular rolls used are 3 in. in diameter by 5 in. long and are driven by a 2 hp. motor. Tests so far made indicate that if the base plate alone will roll to about 0.010 in. in thickness, a welded base plate should do likewise without showing cracks at either the root or apex of the vees or along the side welds.

The test (1) reveals insufficient penetration with heavy stock better than other tests; (2) is cheaper because special test bars are not required; (3) is faster, and tends to concentrate stress at the weld; (4) shows general plasticity of the weld together with the adjoining base metal; (5) is a more satisfactory test to convince the welder of his faults and help him to improve his technique.—R. L. DOWDELL and T. P. HUGHES, *University of Minnesota.*

TREPANNED PLUG INSPECTION

Trepanning may be defined as a mechanical process for removing plugs from a parent base. The tool used, called a trepan, is a circular metal saw with a pilot in the center, which may be either a straight shank drill or some type of pilot bar. An electric drill, a pneumatic motor or a drill press may be used to drive the trepan. In welded sections the trepan should be of sufficient size to include the entire weld seam and enough of the adjacent metal to reveal the degree of fusion.

The American Petroleum Institute code requires at least one plug from each 100 ft. of joint and the proposed addition to the A.S.M.E. code requires one specimen from each 50 ft. Specimens should first be thoroughly cleaned and washed in an oil solvent, preheated in water to 160 deg. F. and then immersed for 30 min. in an etching bath (50 per cent solution of hydrochloric acid) at 160 deg. F.

The principal defects to be looked for in the etched plugs, as noted in both the A.P.I. and the A.S.M.E. codes, are lack of fusion, slag inclusions, gas pockets, cracks and undercutting. Further observation will assist in determining the comparative resistance of the parent plate and the weld metal to corrosion; dirt in the weld or parent plate, if the plug is large; and grain refinement due to the welding heat. Both the A.P.I. and the A.S.M.E. codes illustrate acceptable methods for filling or repairing the holes left by removal of the trepanned plugs.—WILLIAM T. TIFFIN, *University of Oklahoma.*

FIG. 1. MOBILE CONCRETING PLANT SPEEDS WORK ON THE GILA CANAL SIPHON AT FORTUNA WASH.

Equipment Speeds Siphon Work

JOS. C. COYLE
Yuma, Ariz.

***Contents in Brief**—All-machine construction speeds work on a large canal siphon for the Gila Canal in Arizona. Contractor develops mobile units for both construction operations and servicing.*

FAST CONSTRUCTION followed an ingenious use of equipment and good coordination of operations in building a concrete siphon for the Gila Canal across Fortuna Wash near Yuma, Ariz. The siphon was only one item in a larger contract for several structures and the contractor called upon his major plant for general-use equipment but he also devised special equipment for the siphon work, and particularly he made about every task an equipment operation. This account then is largely an exposition of equipment application to a special operation.

The Gila canal has a bottom width of 22 ft. and is 76 ft. wide at the water line; the water will be 13½ ft. deep. It will carry 1,900 cfs, or enough water to irrigate 150,000 acres in the lower elevations of the Gila Project, in which there are 585,000 acres, mostly unoccupied public land withdrawn from entry until water is available. Electric power generated by the Colorado River development will pump water from the canal to irrigate all but 11,000 acres, which lie below the canal level. Headworks are at Imperial Dam, on the Arizona side of the Colorado. The only surface flow in the lower Gila River, along which the project is located, is during very rare flash floods of stormwater. The 19½-ft. siphon barrel is 522 ft. long with a 39-ft. closed transition at each end. The canal enters the siphon between 60-ft. wing walls and the outlet has similar walls 88 ft. long.

The Jahn & Bressi Construction Co., Los Angeles, Calif., was the contractor for the siphon for $97,267; it was Schedule 3 of a general contract covering the construction of a number of structures along the 17-mi. canal.

Construction procedure

When notified to proceed, the contractor moved in a 2-yd. drag-line and started digging at the outlet end of the excavation, which was about 30 ft. deep and some 80 ft. across at the top. Spoil was cast both ways, the dragline working alternately on each berm. There was no water in the excavation. Concrete placing was begun two weeks later, and in 20 days the barrel and outlet structure (3,000 cu.yd.) were concreted, Fig. 2.

Two 8-hr. shifts were worked, the day shift excavating, setting steel and moving forms, and the evening shift doing the pouring. An exciter was provided for a generator and it and the engine were mounted on rubber-tired wheels (Fig. 3) to make light for the job; the rig was carried on one corner of the working platform above the jumbo forms. A light, with reflector, attached to each corner of the platform and others placed at strategic points on the berm lighted the working area.

Jumbo-type metal forms, both inner and outer forms moving on tracks, were used for the barrel. A cable and hand grab at each side of the barrel moved them ahead for each 30-ft. section to be poured. Bolt ties held the forms in place, the rods being left in and the holes at each end grouted. Aggregates were hauled about 2 mi. from a plant operated under another contract, using six

small dump trucks with two-batch metal compartment bodies. Cement was picked up at a storage platform on the way. Water was piped from another job at the Gila River, about 1½ mi. distant.

A 27E paver was spotted on the right berm for each pour. On inlet and outlet structures the mix was delivered to the forms with a pour bucket on the boom of the dragline, but the barrel sections were poured from the mixer hopper moving out on its boom to a loading hopper at the runway level. Rubber-tired buggies were used to convey the concrete from the loading hopper to the forms, where it was distributed through metal tubes, with small hoppers at the top. Vibrators were used to consolidate the concrete in the forms. With a head start on the excavation, the dragline was also able to take time out for handling steel, as well as the wood forms for outlet and inlet structures; those for the transitions were lined with plywood and well oiled.

Setting reinforcement

Ahead of the jumbo barrel forms a small mixer, spotted on the berm, was used to mix concrete for pyramid-shaped footings 12 in. square on top, which supported the assembly of steel reinforcing. A gravity chute, made from scrapped 20-in. metal pipe, carried the mix to wheelbarrows at the foot of the slope. Template rings of 1-in. square bars (Fig. 4) braced vertically and horizontally by welded bars of the same material were wired inside the steel assembly every 3 ft., resting on the pyramid footings, to support the steel in shape while erecting it. Later the rings were cut at the bottom with a torch, and collapsed sufficiently for removal. To use them over they were simply rewelded at the cut. Metal waterstops 30 ft. apart placed in the center of the concrete were welded to the reinforcing at the construction joints.

A shear and power benders were used at the material yard to prepare reinforcing, and a crane was equipped with a 20-ft. extension to the regular 35-ft. boom, for loading and unloading steel. Two flat-rack trucks were used to haul the larger steel from the material yard to the job. The reinforcing used ranged in size from ⅜ to 1¼-in. steel. The usual spacing is 10 in. For moving and cutting the smaller bars at the job a truck was equipped with a metal rack, with a hand shear mounted in the center and a small hand bender on one corner. Thus two men could cut and bend small stuff to order right on the grounds. A transverse angle, supported on braces welded to the front of the chassis, held the ends of the steel in hauling it.

A welding machine, driven by an automobile motor, was used at the job for welding waterstops, templates for reinforcing, pour spouts and for splicing tierods and other purposes. Welder and motor were both mounted on a rectangular frame of 6x6-in. I-beams, which was blocked on channels welded crosswise of the steel truck bottom. A portable-type compressor was also spotted on the berm, to furnish air for the job.

Rock was hauled in 4-yd. dump trucks, from a quarry 1½ mi. away. It was used to fill about the siphon barrel and for dry rock paving and riprap near the inlet and outlet structures. The rock paving is 12 in. thick, the riprap 24 in. The dumped rock was leveled off with a tractor equipped with a bulldozer. It has a 3 to 1 slope from the centerline of the siphon to the excavation banks. Two caterpillars, with bulldozers, backfilled over the siphon barrel and about the structures. This finishing work was done while major equipment moved on to other canal structures.

Fig. 3. Portable power unit provided light for night concreting shift on Gila canal siphon.

The quarry was opened in some low rock ridges through which the canal passes just south of the Gila River and its excavation formed a portion of the canal channel. Using three No. 79 jackhammers, holes were drilled to a maximum depth of 24 ft. in the ridges. They were ordinarily spaced about 14 ft. apart. The holes were sprung three times before loading. Six sticks for the first, 25 for the second, and 75 to 100 sticks for the third chambering, were usually used. Tamping dirt was carefully screened for the springing shots. In the hardest rock the deepest holes were loaded with about 4 boxes of black blasting powder.

The granite in the quarry was extremely seamy, and drillers reported any cavities through which the drills passed, so that they might be built up with sand and save explosives. Less than fifty holes were ordinarily fired at a time, using a blasting machine. Occasional pop shots were required to break up large boulders.

Fig. 2. Looking toward the inlet end of the 19½x522-ft. reinforced-concrete siphon concreted in twenty days.

The rock was loaded with a power shovel. J. B. Stringfellow, subcontractor, operated the quarry.

Servicing equipment

At the company's field shop, serving all the firm's jobs along the canal, an interesting method of rebuilding bucket and shovel teeth is employed. V-shaped points are cut with a torch, one after another, from a 3x4-in. bar

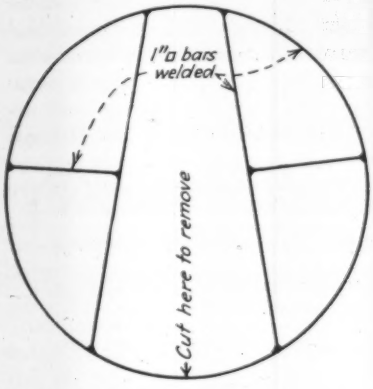


Fig. 4. Welded templets set on concrete pedestals kept siphon barrel reinforcement true to center and circular shape.

Fig. 5. Open V's cut by torch from a 3x4-in. bar were welded to dulled bucket or shovel teeth to sharpen them for reuse.

of plow steel, so that there is little metal wasted (Fig. 5). A worn tooth is driven into the V and the two are closed together under a trip-hammer, after heating in a forge. A bead is then run around the joint, with No. 5 rod, while the metal is still hot. It is then reheated and drawn out to the proper shape with the trip-hammer. To temper the point it is heated to a cherry red and quenched once, then allowed to cool off gradually. In applying plow steel tips to some teeth, stainless steel is used for welding; then after the point is drawn out it is overlaid near the end with high carbon rod to retard abrasion.

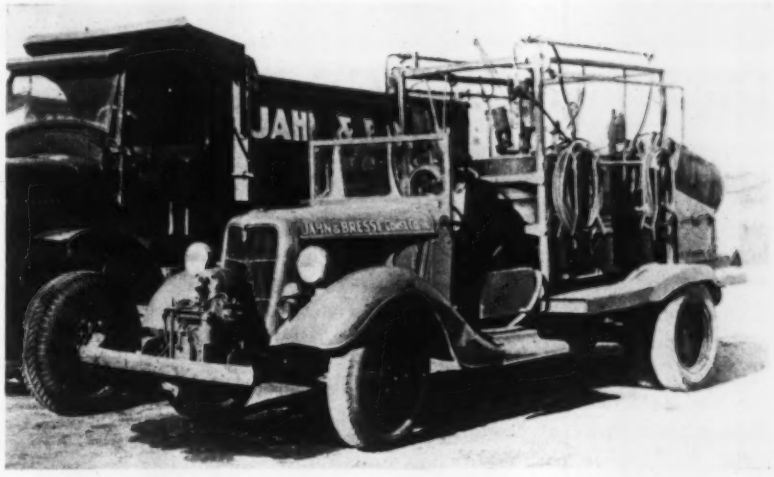


Fig. 6. Field service truck provides grease, oil, compressed air and battery-charging current to equipment needing service on the job.

In order to service trucks, tractors, etc., anywhere in the field, and thus save time, one company truck (Fig. 6) has been equipped as a traveling service station. It charges batteries, lubricates equipment and puts air in the tires wherever the unit may be. The flat rack bed carries 8 bbl. of oil and greases. Air is furnished by a compressor, mounted on a section of 16-in. channel, supported by an extension welded to the truck frame at the front end. The compressor is driven by a short shaft with a universal joint connecting with the front end of the drive shaft of the truck motor. There is a clutch arrangement, with a lever protruding from the frame at the front to disconnect the unit when not in use. The welded framework also supports a ¾-hp. generator, set above the compressor, and driven by a V-belt off the short shaft. A flywheel on the shaft, with spokes that act as a fan, serves to cool the unit when running.

Air is stored in a tank beneath the right running-board of the truck, and distributed through a hollow frame of pipe, with swivel joints at the corners. Air hose is connected to this pipe. When not in use the hose is rolled on metal reels. To these are welded a length of small pipe, by which they are hung up on hooks welded to the vertical pipe frame on each side of the truck.

Fortuna Wash, although normally dry, carries large volumes of water during infrequent storm periods. In order to confine floodwaters to the main channel, where it crosses the siphon, training dikes have been constructed under another contract, protected from washing by breakwaters of rock inside 68-in. mesh wire fencing. The wire is held by railroad rails set in the ground 2 ft. apart. Riprap at inlet and outlet of the siphon connects with these breakwater fences.

R. J. Downs is engineer for the contractors and Joseph Muscolo is construction superintendent. Leo J. Foster is in charge of the Yuma office of the U. S. Bureau of Reclamation, under which the Gila Project is being developed. J. K. Rohrer is resident engineer and W. W. Brenner is associate engineer in direct charge of construction of the Gila canal.

. . .

Harbor for Large Boats Made in Calumet Lake

Improvements to the Calumet River, in Chicago, from Lake Michigan to Lake Calumet, a distance of six miles, including alterations of drawbridges for a widened and straightened channel, are to be made to enable Lake steamers 600 ft. long to pass to Lake Calumet. The city owns some 1,400 acres of land adjacent to the latter lake and has recently awarded a contract for a dock or wharf 720 ft. long, at a cost of $70,000. Transhipment of freight between lake vessels and barges for the Illinois River waterway can be made at this point, and it is suggested that Lake Calumet would be convenient harbor for mooring lake vessels during the winter.

The Bridge of San Cristobal Arroyo

Contents in Brief — Washed out three times in 27 years and twice increased in length as the adobe gulch which it crossed was eroded by flash floods—such is the history of a small bridge in New Mexico. Not unexpected, this history reflects a philosophy of economical bridge building in the Southwest, where compromise rather than control in matters of natural forces pays the best dividends.

LATE IN SEPTEMBER near the small town of Galisteo on New Mexico state highway 41, a bridge fell down for the last time. It was not a large bridge nor a famous one. It was not notable for the amount of traffic it carried and was not an important link in the highway system, however useful it was to local residents and to the few strangers whose travels took them south from Santa Fe along New Mexico 41. It is not even very important or significant that it has fallen down for the last time, for small bridges in this Southwest arid land of cloudbursts and easy erosion are not built for permanency. This singular attitude toward bridge building may be remarked upon by an Iowan or a New Englander but it is regarded as common-sense and sound economics in the Southwest. The Bridge of San Cristobal Arroyo, which fell down for the last time last month, is important because its history is the history of much bridge building in a region where nature must be compromised with rather than conquered.

The history begins in 1912 when San Cristobal Arroyo was 80 ft. wide. Its banks, perhaps 15 ft. high, were nearly vertical, a typical result of adobe clay erosion. To get the highway across this barrier a bridge was required, and an 80-ft.-span steel pony truss with laminated timber floor and timber stringers was provided, founded on plain concrete abutments. Perhaps because of available labor or on the score of economy all joints were bolted rather than riveted.

It was a serviceable, economical structure, and for two years its existence was uneventful. Then, in August, 1914, a flood undermined the north abutment, which tipped and dropped the span part way into the stream, bending some of the members considerably. Salvage and rebuilding were ordered. The damaged abutment was replaced by a reinforced concrete pier set upon timber piles driven inside two 4-ft.-diameter steel tubes, and the truss was raised back to position and its damaged parts replaced.

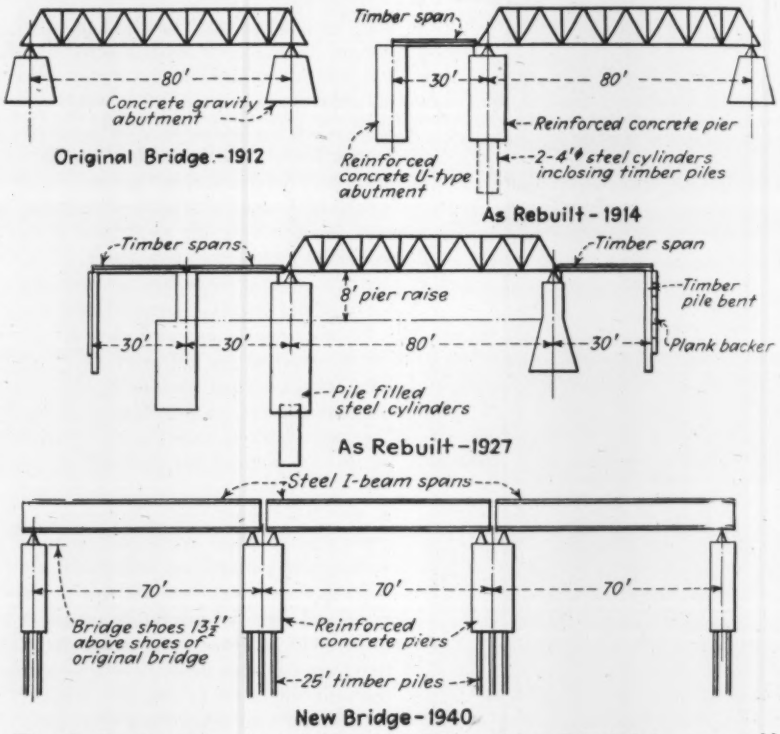


Fig. 2. Results of the rise and fall of the Bridge of San Cristobal Arroyo as told in its several rebuildings and finally by its proposed new successor.

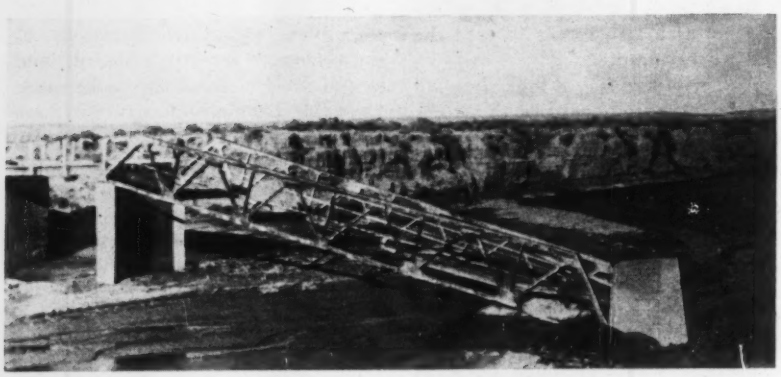


Fig. 1. San Cristobal Arroyo and the bridge which has been down three times and up twice in its 27 years of battling bank erosion and streambed scour.

Since the extreme scour had also widened the arroyo, a 30-ft. treated-timber span was added at the north end to preserve the increased waterway for future floods. A reinforced concrete abutment was built under the north end of the timber span.

For thirteen years the 110-ft. waterway under the two-span bridge carried floods without incident. But

in September, 1927, a flood overtopped the bridge floor by several feet. The substructure resisted damage but the truss, buoyed up by its timber floor, floated about 400 ft. downstream before the water subsided to pile it up on the bottom of the arroyo. Damaged but not destroyed, the steel span was taken apart, its members replaced or straightened, and then re-erected with riveted instead of bolted joints.

However, because of the extreme high water of this latest flood, two changes were made to increase the waterway area: the roadway was raised 8 ft. by adding concrete pedestals to the foundations and a 30-ft. treated timber span was added to each end of the existing structure, the abutments of these new spans being treated timber piles, with backing plank to retain the earth. San Cristobal Arroyo was now 170 ft. wide. Its banks were still vertical and its waterway cross section at the bridge was 2,500 sq.ft. or more than twice what it was in 1912.

Patchwork the Bridge of San Cristobal Arroyo surely was, but as events proved it was good for twelve years more. Then the rains came, and once again in September the bridge experienced disaster. This time the south abutment of the steel truss, one of the original ones to which an 8-ft. pedestal had been added in 1927, was undermined to such an extent that it tipped forward. The weight of the truss broke off the pedestal, and the south end of the span dropped into the stream. Examination showed that 27 years of service and the three collapses had taken too great a toll for repair to overcome. The steel span was cut up with torches and removed as scrap. The bridge of San Cristobal Arroyo had fallen for the last time.

The old foundations still remained. They were good enough for more patchwork, but a new factor had to be considered. Traffic was not the same as it was in 1912. Ranchers, who then rode horseback or drove buckboards, now used automobiles. The occasional stranger of three decades ago had increased to an army of tourists, attracted by the scenic wonders of the Southwest. A more permanent, wider and better looking bridge was a necessity. The New Mexico highway department, according to latest advices, is preparing to build it. The new bridge will consist of three 70-ft. I-beam spans with a concrete slab deck and with reinforced concrete piers set on untreated timber piles 25 ft. long. Furthermore, the new bridge will be 5½ ft. higher than the old, or 13½ ft. above the original structure.

Engineers are sure the new bridge will stand the buffeting of the floods that are certain in this land of heavy but infrequent rains, fast runoff, steep stream slopes and extreme erodability. They hope that the 3,500-sq.ft. waterway, 25 per cent greater than the maximum flow of record, will suffice for all future floods.

But they hold no illusions about predicting the maximum flood. Next September or 12 years hence a new maximum flood may occur. If it does and the arroyo is widened further, new spans can be added to the ends of the bridge. In any event, it is certain that the decision will be to compromise with nature and not to try to control it. The history of the Bridge of San Cristobal Arroyo is proof enough that that is a proper philosophy for southwest bridge builders to embrace.

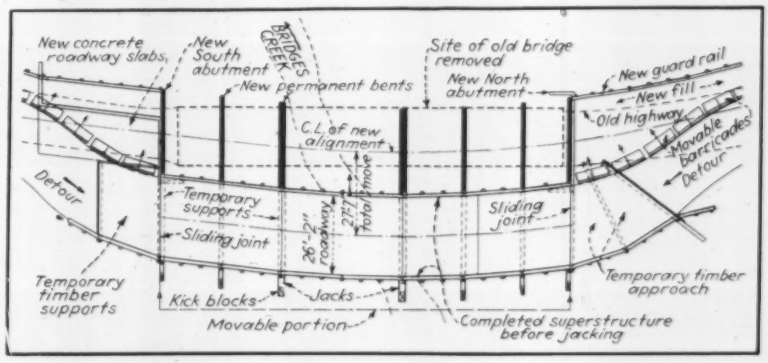
Traffic Uses Bridge Deck During Lateral Movement

To avoid any traffic interruption, an old timber highway bridge in northern California was recently replaced with a modern concrete structure by the novel expedient of routing traffic over the new superstructure while it was being skidded into place from falsework alongside the old bridge. The entire job of replacement was completed in a little more than five months at a total cost of $25,000, which was less than the cost estimate of the engineers.

Heavy commercial traffic made it inadvisable to cause any interruption to travel on the main highway route leading south out of Garberville, Calif., and when it became necessary to replace the small timber bridge across Bridges Creek, 21 miles south of that point, endeavor was made to locate a good detour. Finding a detour impracticable because of a steep, narrow ravine, a plan was developed whereby the new concrete superstructure was cast on falsework alongside the old bridge, thus providing an excellent temporary route while the old bridge was removed and new foundations prepared. On bent caps coated with tallow, the new superstructure was then slid laterally into its permanent position.

A 20-ton ratchet screwjack was placed at each of the seven bents and all were operated simultaneously on signal. The superstructure was moved 26 ft. 7 in. in 7 hr. with the total movement from falsework to the permanent alignment completed in 11 hr.

F. W. Panhorst is bridge engineer of the California Division of Highways. The contractor was Claude C. Wood, Lodi, Calif.

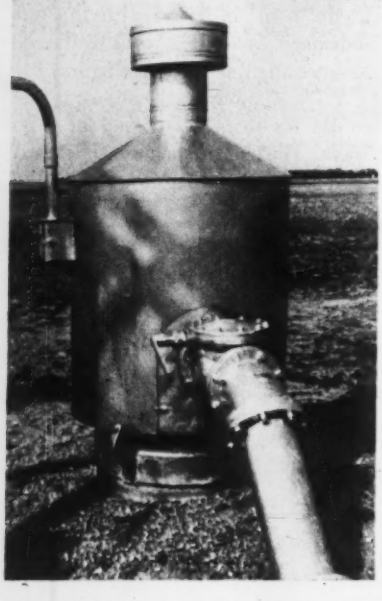


Conveniently available space made it possible to build the new deck alongside the old bridge, thus keeping the old bridge in service.

Removable Well Houses Simplify Maintenance

A WELDED CIRCULAR COVER costing $75 is used by the Illinois Water Service Co. at the Champaign and Urbana (Ill.) waterworks to replace wood or brick houses over individual wells and pumps costing ten times as much. The cover which incloses the motor is 48 in. in diameter and is made of ¼-in. steel plate. It has a hinged door permitting access to the motor for oiling, inspection and minor repairs. On the top is a ventilator through which cooling air is driven by the rotating motor; the air being drawn in at the bottom through an annular space between the cover and the 36-in. well casing. The cover is supported by four angles bent to form shelves and welded to the casing just above ground level.

The former well houses provided shelter for the motor and pump, but if the strainer had to be pulled to rehabilitate the well the wooden houses had to be moved on rails to one side. In the case of a brick well house, an end wall would be knocked out, and the opening subsequently boarded up. Using the new steel shelters, work requiring rehabilitation of the wells or repairs to the pump and motor can be done in the open. The covers in this case are lifted off after the electrical cable connection has been disconnected. To facilitate removal of a cover the outlet pipe from the pump is surrounded with a detachable plate.



Removable steel well covers replace wood and brick housing.

Wooden well houses had to be skidded to one side to permit the well-drillers' rig to be set up over the well to remove the casing.

Brick well house, the end wall of which was knocked out when time came for rehabilitation.

Rehabilitation ordinarily is required at 5-yr. intervals and is caused by clogging of the well screen with lime deposits. Simply lifting the screen, which is 40 to 50 ft. long, usually dislodges the lime sufficiently without further treatment. In a recent rehabilitation job a screen 16 ft. in length was replaced by a 40-ft. screen which reaches entirely through the gravel and sand aquifer of that depth between yellow clay layers. The water company contracted with the Layne-Western Co. on a per diem basis to make this change.

Damage to the pumps at time of interception of power supply is avoided by having the relay switches controlled by a telechron clock, all housed near the transformers.

Wells in this field produce from 750,000 to 1,250,000 gpd with an average drawdown of 1½ ft. per 100 gal. Water stands 146 ft. below ground level before pumping. The maximum depth of the wells is 225 ft.

Outdoor transformers step down the 4,000-volt current to 220 volts. A control house located near the transformers, has in it an automatic relay switch which, when opened by an outage due to interruption of current, is closed again in correct sequence with the other wells by a telechron clock time-limit switch. The clock is set to permit full drainage of the water in the pump column. A check valve shuts off the discharge pipe close to the pump. Thus the backward rotation of the pump and motor due to the drainage down the pump column will have ceased prior to the 2½-min. holdup by the clock. This form of protection is preferred to the usual thermo overload relay cutouts which require manual starting when blown.

Frank C. Amsbary, Jr., is superintendent of the Illinois Water Service Co. He designed the new type of housing.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

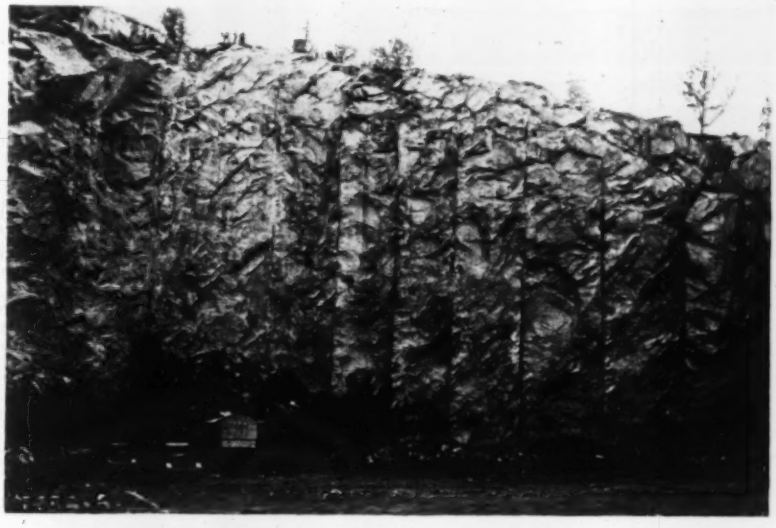
Drill Hole Size Tests At Hiwassee Dam

C. E. BLEE
Project Engineer
Hiwassee Dam, N. C.

Well drills producing a hole 9 in. in diameter have been used for the blasting in the quarry at Hiwassee Dam. All the aggregate, including the sand, used in the concrete for the dam and powerhouse, are manufactured from the rock produced in this quarry. Drilling has now been completed for the production of all this rock, amounting to about 1,700,000 tons.

At the time of ordering the drilling equipment, it was not certain whether 6- or 9-in. holes would give the best overall economy. The rigs were specified to have sufficient capacity to handle either size of tools, and a string of tools of each size was ordered. From the tests made with the two sizes it was soon evident that the 9-in. hole was the more economical and this size was adopted as the standard. The drilling speed measured in lineal feet of hole drilled was fully as fast with the 9-in. hole as with the 6-in., the greater weight of the string of tools compensating for the greater area of cutting. The average rate of drilling the 9-in. holes, including moving time, was 3.7 ft. per hour. The holes are loaded solid with powder and the amount of rock produced per foot of hole is almost directly proportional to the area of the hole so that a 9-in. hole produces more than twice the amount of rock that a 6-in. hole would produce. The spacing of the 9-in. holes can be increased accordingly. This spacing was developed by trial and varied with special conditions, but the normal spacing, where shooting was parallel to the grain of the rock, was 45 ft. of holes with 24-ft. burden (distance back from the face). One row of holes is shot at a time. The reduced number of drill set-ups required was a considerable factor in reducing costs. The drill rigs were mounted on steel skids and moving from one set-up to another, over the very steep and rough rock surface, was slow and difficult.

As far as could be observed, there was no difference in the fragmentation obtained from the two sizes of holes. Fragmentation was important as this greywacke rock breaks very blocky and the secondary blasting is a considerable element in the overall cost of the rock.



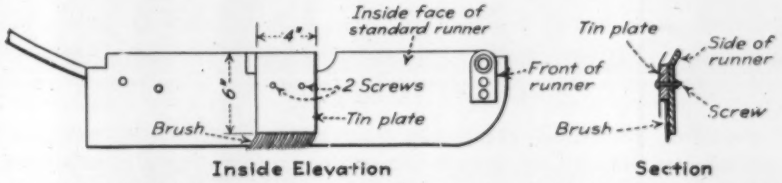
Quarry face at Hiwassee Dam, showing the manner in which the rock breaks along the line of blast holes, leaving half of the 9-in. hole in the face. In the lower left-hand corner is shown one of the 2¼-yd. electric shovels and two of the 12-yd. trucks used in loading and hauling the rock.

CAMERA MEMORANDA

After an engineer at Hiwassee Dam had an eye nearly made blind by the swing of a rod carried on a man's shoulder, this sign went up.

Splash Guard for Stripe Painting

To eliminate splashing and insure a clean edge in painting traffic stripes on pavement, District 15 of the Texas highway department uses the device illustrated by the accompanying sketch. A 4-in. paint brush is split lengthwise and the bristles are thinned out so as to mark only a thin line. A brush is fastened flat against the inside of each runner of the striping machine as shown by the sketch, just back of the spray nozzle and so that the bristles drag about ¼ in. on the pavement. A tin shield covers each brush to about 1½ in. above the pavement so that the paint spray hits only the lower edge of the brush and gives it just enough paint to mark a defined line.—F. S. HADDOX, *district engineer, in "The Information Exchange," Texas Highway Department.*



Brushes on insides of striping machine runners give clean sharp edges to traffic stripes.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

TRAY FILTERS—Tray aeration has been used for a long time in water purification, especially to oxidize iron. Methods of introducing air to trickling filters have been presented on various occasions with indifferent, good or variable results. Treatment of sewage on a series of filters is practiced at low or high rates, with or without circulation, for settled sewage or activated sludge effluent and various combinations. Beger in Germany placed a series of trays on top of each other or behind each other, while at Rothamsted, England, interchangeable trays placed on top of each other have been used for several years. Damoll and Liebmann (*Gesundheits, Ingenieur*, Aug. 12, 1939) describe and give results on interchangeable trays placed above each other about 2½ in. apart used for institutional sewage.

It was found that the dropping of sewage through the air from tray to tray (using seven trays) affects the flora and fauna on the filter medium materially, resulting in considerably improved purification as compared with trays placed on top of each other. Compared with ordinary trickling filters the rate of application can be increased several times with the same results. The trays can be filled with stone, slag, coke or any other media used and appear particularly adaptable to small installations, hospitals and other institutions.

RESERVOIRS AND MALARIA—It has long been recognized that clearing of reservoir sites is essential in connection with malaria control on impounded waters. Part of biological control of the malaria-transmitting mosquito are the steps taken to eliminate or limit the environment suitable for producing the insect and secure a practically clean water surface. Natural forces are constantly at work to re-establish a favorable environment through the growth of weeds, grasses, shrubs, accumulation of drift and floating material. The influencing factors vary in different reservoirs according to topography, character and location of growth, fertility of soil and extent of marginal shallows and protected arms.

The Tennessee Valley Authority (*Report*, Symposium on Malaria, 1939) considers it essential to take into consideration water level fluctuations, and has set up specifications of which the principal requirements are: (1) that the reservoir be cleared so as to present a clear water surface after impoundage between maximum and minimum water levels; (2) all depressions between maximum and minimum water levels be drained to provide water level fluctuation with the lake. These requirements, together with clearing of banks, cliffs and tributaries, resulted in great savings of larvicide applications, easier control and less mosquitos. For instance, the Pickwick reservoir extra marginal conditioning cost about $40,000, while the saving on larvicide operations amounted to $20,000 during the first year.

BULKING SLUDGE—English and American operators of activated sludge plants have noticed time and again that a protracted spell of dry weather results in bulking. After a heavy rain the settling characteristics of the sludge may be restored almost overnight. However, the sludge concentration carried in the aeration chambers may be less than usual and a short dry spell following again results in bulking, often more severe than before. Increased oxygen supply is necessary, but the condition of the sludge may have changed to such an extent that it requires very large amounts of air even to retard bulking. A heavy rain, producing increased flow with possibly some dissolved oxygen, dilutes the sewage. The oxygen supply per million gallons is the same or is increased, resulting in more oxygen to satisfy the demand.

Inert suspended matter (clay and sand) carried by the stormwater may aid. Pin-point floc may be washed out of the sludge. All these factors result in denser sludge, but because the sludge changes gradually the relief is often temporary. The air requirement may be so large that it can be supplied only over an extended period with gradual improvement. Larson (*Annual Report*, Springfield Sanitary District, 1938) has tucked away in his report a large amount of interesting information bearing on this point. A few figures assembled (monthly averages) with and without bulking are illustrative:

	Non-bulking	Bulking
B.O.D. raw sewage, ppm.	203	203
B.O.D., effluent ppm.	21	27
Nitrates, effluent ppm.	2.2	4.6
Sus. sol. mixed liquor ppm.	2,331	1,316
Sludge index	120	243
Hours aeration	7.1	8.1
Lb. O_2/ lb. B.O.D. removed	7.95	18.4
Displacement of sludge, days	5.1	14.2
Hp./mg.	21.6	28.3

With the same B.O.D. of sewage and equivalent purification, but reduced suspended solids, the oxygen required to remove a unit of B.O.D. was nearly doubled, resulting in increased cost. The displacement time of the sludge in the aeration tanks shows why the sludge would be easily upset by another short period of dry weather.

BOTTLES BREED BACTERIA—It has been known for some time that the bacterial population of surface waters stored or brought to the laboratory may be many times greater than that found in the streams or lakes themselves. This has caused considerable difficulty in interpretation of results on stream surveys. Stark, Stadler and McCoy (*Journal* Bacteriology, 36, Dec., 1938) have found that when the area of solid surface per given volume is increased the number of bacteria are increased. Accumulating small amounts of organic matter from sterile water over a period of hours on the surface of chemically clean glass slides it was shown that the accumulation was independent of and precedes bacterial growth. It appears that the glass bottles accumulate sufficient concentration of suitable nutrient material to cause an increase in bacterial growth which would not take place in surface waters where the bacteria are found naturally and the nutrient concentration is low. The low concentration of this nutrient material is one of the important factors controlling the growth of bacteria in surface waters.

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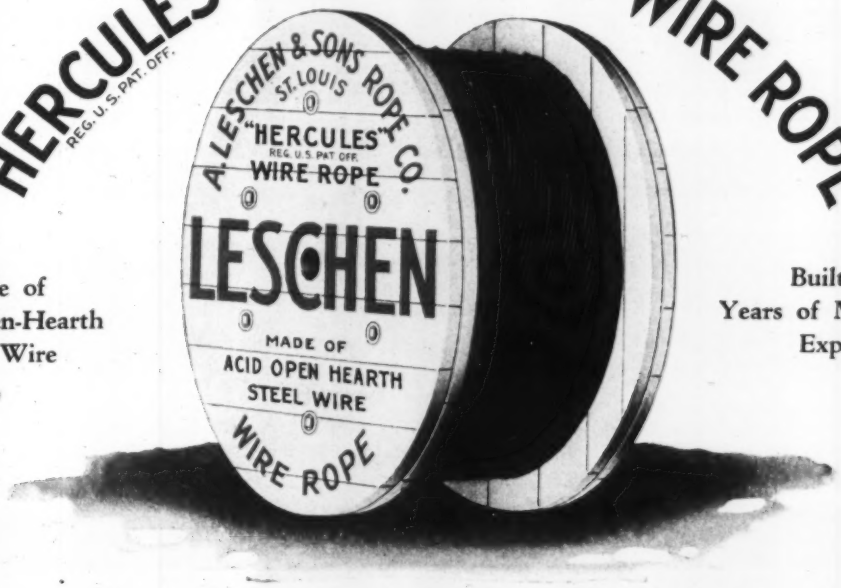

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Works Economics Studied by FWA

Investigation to be basis for prediction of new works program effect

Now approaching completion in the offices of the Federal Works Agency is a statistical study on the basis of which it will be possible to predict in great detail the exact economic effect of an existing or proposed public works program. In its immediate form, the study will show for each month of the current fiscal year how many man-hours of labor and how much of each type of construction material will be required in each state by the present public works program—highways, housing, buildings, and PWA. Because of the variable nature of its work, WPA is broken down by states, but not by months.

The study moreover has developed formulas by which the same analysis could be made, for the guidance of Congress, of a proposed program. Further, these methods, it is believed, could be used to formulate a tailor-made works program—designed to provide so much employment at a particular place and a particular time.

Principal benefit expected however is the help to be given to industry in predicting its market. It was originally planned to announce the results of the study at a conference of industrialists sometime last month. Everyone has been so busy, however, since the outbreak of war, that the conference has been dropped and it is not yet decided when or how the figures will be published.

In charge of the study is George W. Babcock, FWA management engineer, who was brought to the agency from REA when Carmody became works administrator.

Method followed has been to analyze the progress charts of a large number of every type of project undertaken by the various works agencies. It was found that, plotted against percentage of completion, employment of labor and utilization of the different materials fell into definite curves for each type of construction. These patterns varied in a regular way, it was found, according to the part of the country and the time of year in which work was started. It is now believed that, given a description of a project, it is possible to draw in advance a pattern to which the actual progress of the work will correspond closely.

. . .

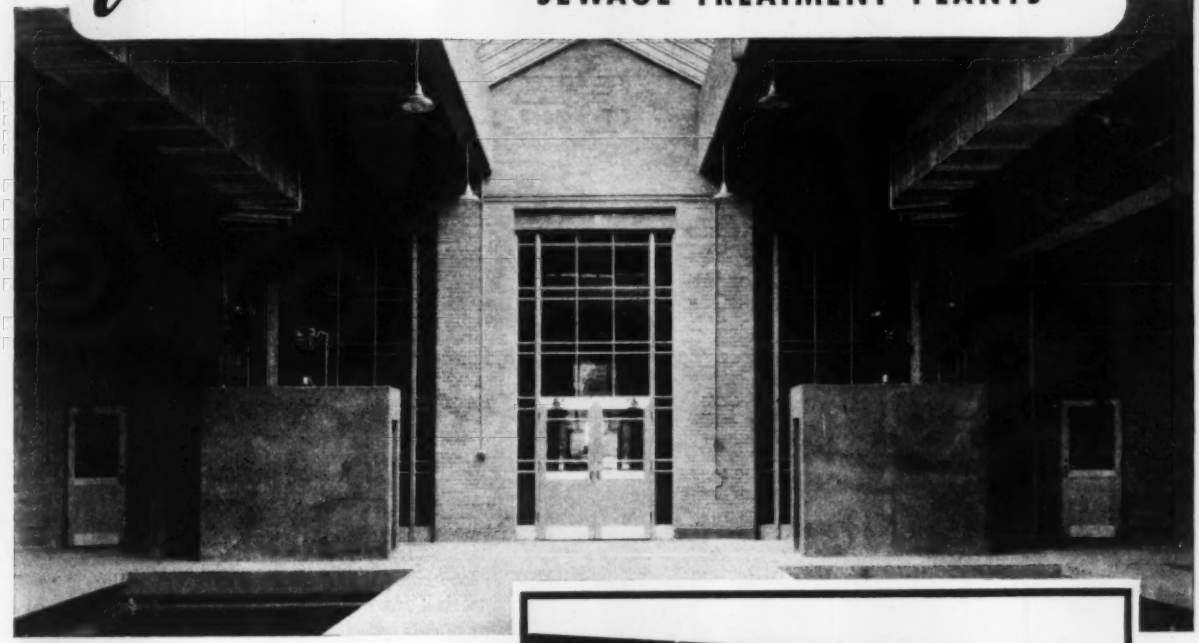
Storm-Flood Damage In California

A rainfall of 6.43 in. in 24 hours was a record made in the torrential storm of Sept. 4 to 6 in Riverside and Imperial counties, California, as noted by E. E. Wallace, district highway engineer, in *California Highways and Public Works*. This record was at Brawley, Calif., and is three times the average annual rainfall of this district. The flood waters washed out 35 miles of highway, approaches to six bridges, and a number of levees protecting irrigated lands. State maintenance crews prepared for work as soon as the storm started, and though some equipment was marooned all available state equipment and 43 pieces of rented equipment were assembled to clean the roads and make repairs. Detours were constructed at the six bridges and traffic was permitted as soon as a one-way road could be opened. Much damage was done also to the Southern Pacific Ry., train service being stopped for two or three days in some places and passengers were transferred by bus. Damage to crops, canals and structures in the Imperial Irrigation District was estimated at $250,000. The 3-day rainfall was in the Coachella valley centering near Indio, Calif., and broke all previous flood records. On Sept. 25, while highway repair work was in progress, another storm of cloud-burst intensity struck the valley, and water 18 in. deep flowed through Indio. More damage was then done to both the highways and the railway. With a 6-in. rainfall within a few hours the total for the storm period of September was about 11 in. Highway restoration work, including rebuilding of the roads to a standard that will secure them against damage by other storms of similar intensity, will cost some $500,000.

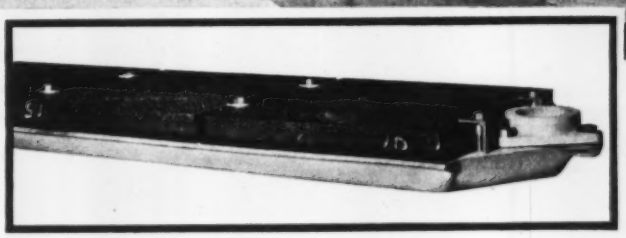
YOU'LL FIND

Alcoa Aluminum Alloys

ON MANY IMPORTANT JOBS IN SEWAGE TREATMENT PLANTS



From skylights to diffuser plate holders, much of the metal here is long-lived Aluminum.



Burger diffuser plate holders add greatly to plant efficiency; it is easy to change plates.

Aluminum skylights, coping, spandrels, grilles, windows, doors, and sills are all serving a double purpose: helping to preserve the fine appearance of a plant, while holding maintenance costs to a minimum. Aluminum does not rust and it requires no protective painting.

Aluminum ventilators, ducts and heaters, electrical conduit and housings, floor gratings, stop gates and diffuser plate holders; this is equipment vital to the efficient performance of the modern sewage disposal plant. It adds to the efficiency of that operation by its ability to resist the attack of corrosive fumes.

Our engineers will welcome the opportunity to assist you in determining how Alcoa Aluminum Alloys can best serve you. ALUMINUM COMPANY OF AMERICA, 2108 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

WASTEWAY, WASHINGTON

OWNER: Bureau of Reclamation, Roza Division, Yakima project, Washington. R. F. Walters, Chief Engineer.

PROJECT: Earthwork, concrete lining and structures necessary for construction of 3½ mile Wasteway No. 3, Yakima Ridge Canal, Roza Division, Yakima project, about 10 miles southeast of the city of Yakima, Washington. Involves construction of concrete floor on river bottom where wasteway returns to river, in order to prevent undermining piers of nearby bridge.

CONDITIONS: Owner to furnish cement and reinforcing steel; contractor to furnish all other materials. Highway transportation available. Project to be completed in 400 calendar days. Wages specified are: skilled labor, $1.75 per hr.; semi-skilled, $1.25; and common, 70c. per hr.

BIDS: Five bids were opened July 15, 1939, ranging from the contract low of $158,966 to $247,970.

LOW BIDDERS:

1. H. J. Adler Constr. Co., Yakima, Wash.....$158,966
2. J. A. Terteling & Sons, Boise, Idaho..... 174,061
3. Barnard-Curtis Co., Yakima, Wash..... 178,491

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Common excav., wasteway	170,000 c. y.	$0.20	$0.13	$0.13
2. Rock excav., wasteway	2,000 c. y.	.35	.40	.13
3. Common excav., struct., (except stilling pool and R. R. crossing)	700 c. y.	.75	.75	1.00
4. Rock excav., struct. (except stilling pool and R. R. crossing)	20 c. y.	2.00	1.00	2.00
5. Common excav., stilling pool and R. R. crossing	12,000 c. y.	.25	.60	.50
6. Rock excav., stilling pool and R. R. crossing	50 c. y.	2.00	1.00	.50
7. Overhaul	1,000 sta. y.	.03	.05	.05
8. Compact. embankments	9,000 c. y.	.25	.15	.25
9. Prep. rock found. for conc. lining, rect. sections and transitions	1,000 s. y.	.65	.75	.50
10. Trim earth found. for conc. lining, rect. sections and transitions	52,000 s. y.	.30	.40	.35
11. Backfill	15,500 c. y.	.10	.25	.20
12. Puddle or tamp. backfill	2,000 c. y.	.40	.70	.45
13. Conc., structures (except stilling pool and R. R. crossing)	453 c. y.	13.00	16.50	26.00
14. Conc., stilling pool and R. R. crossing	825 c. y.	12.00	17.00	17.25
15. Conc., rectangular sec. and transitions	2,220 c. y.	11.30	13.00	12.50
16. Concrete in conc. lining	5,100 c. y.	7.00	8.00	8.50
17. Reinf. bars	800,000 lbs.	.015	.015	.02
18. Dry rock paving	400 s. y.	2.00	1.00	2.00
19. Erecting timber, struct	10 M b.m.	23.00	20.00	30.00
20. Install. 8-and 10-in. metal pipe	1,050 lbs.	.05	.04	.05
21. Install. 16-and 18-in. metal pipe	2,500 lbs.	.05	.04	.10
22. Constr. 6-in. underdr., uncemented joints	12,000 l. f.	.65	.50	.60
23. Lay. 6-in. sew. pipe cemented joints	3,000 l. f.	.30	.30	.35
24. Install. gates, gate hoists	27,500 lb.	.04	.03	.05
25. Install. misc. metalwork	1,200 lb.	.10	.05	.10
26. Install. elect. metal conduit	150 l. f.	.10	.25	.50
27. Install. elect. conductors and ground wire	35 lb.	.10	.50	1.00

RAISING BRIDGE, WASHINGTON AND OREGON

OWNER: Wauna Toll Bridge Co., Walla Walla, Wash.; C. G. Huber, Portland, Ore., engineer.

PROJECT: Raising Bridge of Gods over Columbia River 45 ft.; grading approaches and enlarging piers, at Cascade Locks, Ore., between Washington and Oregon.

CONDITIONS: Contractor to furnish all materials, and finish project by August 15, 1940. Rail, highway and water transportation facilities available. Wage rates are: skilled $1.50 per hr.; semi-skilled, $1.25 per hr.; and common 60c. per hr.

BIDS: Five bids were received August 3, 1939, ranging from the contract low of $438,543 to $532,442.

LOW BIDDERS:

1. Tavares Constr. Co., Los Angeles, Calif.....$438,543
2. Pacific Bridge Co., San Francisco Calif..... 449,815
3. MacRae Brothers, Seattle, Wash..... 486,636

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Structural excavation	1,040 c. y.	$2.00	$5.52	$6.00
2. Rock revet., pier 1W	350 c. y.	5.00	3.50	3.70
3. Class A concrete	160 c. y.	30.00	38.30	21.00
4. Class B concrete	160 c. y.	30.00	28.90	21.00
5. Class C concrete	2,178 c. y.	25.00	19.78	22.00
6. Class D concrete	2,998 c. y.	25.00	16.95	21.00
7. Class E concrete	163 c. y.	16.00	15.00	20.00
8. Reinforcing steel	495,329 lb.	.075	.0471	.05
9. Struct. steel, appr. span	620,600 lb.	.09	.075	.0935
10. Struct. jacking oper.	952,000 lb.	.11	.062	.15
11. Suspended span	L.S.	16,500.00	71,138.00	16,500.00
12. Jacking operations	L.S.	34,500.00	86,610.00	68,000.00
13. Remove and replace timber	L.S.	1,700.00	1,550.00	13,500.00
14. Nailing strips	7Mbm.	105.00	150.70	120.00
15. Lumber, west approach	800Mbm.	52.00	45.70	65.00
16. Railing	1,946 l. f.	1.50	4.35	1.00
17. Clear and grub (Ore.)	L.S.	1,000.00	6,000.00	2,275.00
18. Approach grading (Ore.)	16,600 c. y.	.35	.35	.40
19. Approach grading (Wash.)	L.S.	1,600.00	5,000.00	1,025.00
20. Fine grading	L.S.	700.00	2,500.00	1,050.00
21. Crushed rock	2,765 c. y.	3.50	2.00	1.90
22. Bitum. macadam wear. surf.	5,170 s. y.	1.00	1.00	.40
23. Bitum. treatment, shoulders	3,120 s. y.	.35	.40	.20
24. Electrical work	L.S.	8,000.00	6,607.50	9,000.00
25. Walk, curb, basin, drain	L.S.	1,000.00	1,000.00	820.00
26. Toll house, stairway, water dept.	L.S.	1,000.00	1,100.00	800.00

STREET PAVING DULUTH, MINNESOTA

OWNER: City of Duluth, Minn.; T. F. McGilvray, city engineer, Duluth.

PROJECT: Improving and reinforced-concrete paving Forty-Fifth Avenue East from Superior Street to Glenwood Street, Duluth, Minn.

CONDITIONS: Contractor to furnish all materials and complete work by November 20, 1939. Rail, highway and water transportation facilities available. Minimum wages specified are: skilled, 67½c. per hr.; semi-skilled, 62½c. per hr.; and common, 62½c. per hr.

BIDS: Six bids were received Aug. 23, 1939, ranging from the contract low of $48,700 to $53,720.

LOW BIDDERS:

1. John Wiinamaki, Duluth, Minn. (contract)... $48,700
2. Central States Constr. Co., Crosby, Minn..... 50,187
3. Arrowhead Constr. Co., Duluth, Minn..... 51,938

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Earth excavation	3,600 c. y.	$0.35	$0.50	$0.42
2. Rock excavation	30 c. y.	.35	.50	.42
3. Earth excav., trench	200 c. y.	1.35	1.75	1.50
4. Rock excav., trench	5 c. y.	1.35	6.00	1.50
5. Approved backfill	100 c. y.	.90	1.25	1.00
6. Cold patch bitum. mixture	10 c. y.	10.00	10.00	10.00
7. Remove conc. pavement	60 s. y.	2.50	1.00	2.00
8. Reinf. conc. pavement	19,700 s. y.	2.10	2.16	2.25
9. Remove conc. crosswalk	50 s. y.	.50	1.00	.20
10. Remove concrete walk	80 s. y.	.25	.30	.20
11. Concrete walk	700 s. f.	.25	.22	.20
12. Adjust manholes	15 ver. f.	2.00	5.00	1.00
13. Remove concr. header	375 l. f.	.30	.30	.10
14. Concrete header	720 l. f.	.40	.25	.35
15. Remove concr. curb	200 l. f.	.25	.25	.10
16. 6-in. integral crub	8,900 l. f.	.25	.22	.26
17. 10-in. reinf. conc. pipe	200 l. f.	.95	.90	.85
18. 12-in. reinf. conc. pipe	150 l. f.	1.00	1.15	1.00
19. 15-in. reinf. conc. pipe	550 l. f.	1.40	1.30	1.25
20. 21-in. reinf. conc. pipe	50 l. f.	2.15	2.00	2.25
21. Remove 12-in. plank culvert	60 l. f.	.25	.50	.15
22. Remove 4-ft. plank crossing	60 l. f.	.25	.15	.15
23. Remove, relay plank walk	100 l. f.	.50	.35	.15
24. Lumber, in place	1 M.b.m.	60.00	30.00	55.00
25. Remove inlets	20 ea.	5.00	5.00	5.50
26. Remove and replace No. 27 inlets	18 ea.	18.00	25.00	25.00
27. No. 27 inlets	20 ea.	25.00	25.00	24.00
28. Manholes	2 ea.	65.00	60.00	65.00
29. Monument boxes in place	6 ea.	6.00	10.00	8.00
30. Reinforcing bars	100 lb.	.10	.05	.08
31. Manhole rings and covers	3 ea.	20.00	15.00	15.00

To Engineers

WHO WANT QUALITY CONCRETE

THEY say that Time will tell! Well, Time has told—and here is what it says about the long-time performance of 'Incor' 24-Hour Cement.

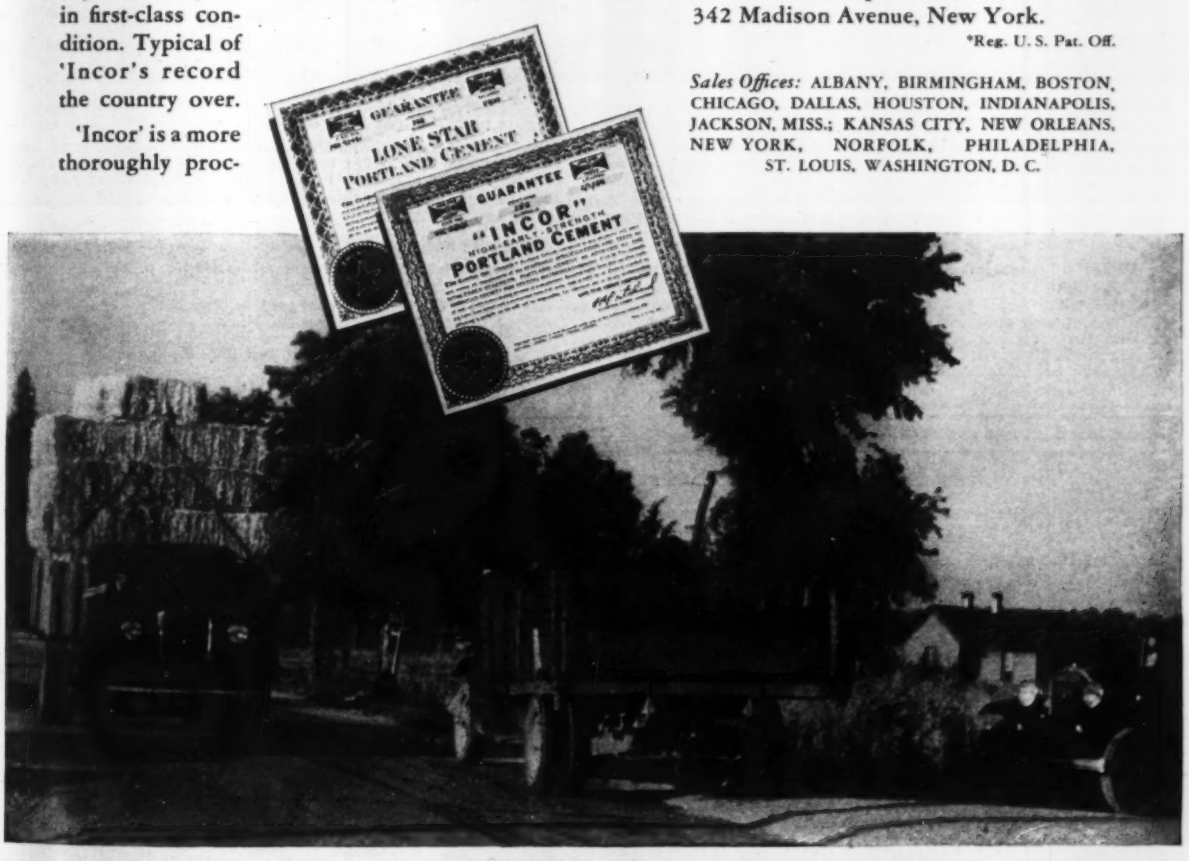
Back in 1927, to avoid delay to cement shipments, Manhattan Road intersection near the Lone Star mill at Limedale, Ind., was repaved with 'Incor' 24-Hour Cement. Weather was cold and rainy, but concrete was opened to traffic in 40 hours, when a string of Mack trucks carrying a total load of 2100 bbl. cement, 75 sacks to the truck, passed over the new 'Incor' concrete. Today, after 12 years' hard service, this concrete is in first-class condition. Typical of 'Incor's record the country over.

'Incor' is a more thoroughly processed Portland cement, choice of engineers and contractors who want top-quality concrete. Dependable 24-hour service strength speeds construction and reduces form, time and cold-weather-protection costs.

It pays to estimate every job with both Lone Star and 'Incor'. Use 'Incor'* if it shows you a net profit—otherwise, use Lone Star, the Portland-cement quality standard ever since 1900. Written quality guarantee with every shipment. Write for copy of "Cutting Concrete Costs." Lone Star Cement Corporation, Room 2280, 342 Madison Avenue, New York.

*Reg. U. S. Pat. Off.

Sales Offices: ALBANY, BIRMINGHAM, BOSTON, CHICAGO, DALLAS, HOUSTON, INDIANAPOLIS, JACKSON, MISS.; KANSAS CITY, NEW ORLEANS, NEW YORK, NORFOLK, PHILADELPHIA, ST. LOUIS, WASHINGTON, D. C.



LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT • • • 'INCOR' 24-HOUR CEMENT

MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

LUMBER and steel provide the most important price changes in the November construction material market. Lumber continues the October activity with 13 of the ENR reported cities showing changes. Pine is up $2.00 to $5.00 in Chicago and New Orleans; up 50c. to $1.00 in Cleveland; up $1.00 to $5.00 in Denver; up $6.00 to $9.00 in Detroit; up $1.00 to $1.50 on 1- and 2-in. sizes in Kansas City; up $1.00 on 1-in. in Minneapolis; up 50c. in Philadelphia; and up $1.00 in St. Louis. Pine is off $1.00 in Atlanta. Douglas Fir is up $2.00 to $6.00 in Chicago; up 50c. and $1.00 on 2-in. sizes in Kansas City; up $1.00 on small planks in Los Angeles, but $2.00 to $3.00 lower on most other sizes; up $1.00 in Minneapolis and Philadelphia; up $3.00 to $4.00 in New Orleans; and up $2.50 to $3.50 in San Francisco.

Structural steel shapes are 5c. per 100 lb. higher in Baltimore; 15c. higher in Detroit; up 55c. in Montreal; and up 50c. in New Orleans. Reinforcing bars are higher in Atlanta, Baltimore, Birmingham, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Minneapolis, New Orleans, Pittsburgh, St. Louis and San Francisco. Higher scrap steel prices have cut the former 15c. differential between new billet and rail steel bars in many of the cities.

In New Orleans skilled labor rates have increased 50c. per hr. for bricklayers and hoisting engineers, 20c. per hr. for carpenters, 25c. for structural ironworkers, and 40c. per hr. for plasterers. Structural ironworkers now receive $1.65 per hr. in Philadelphia, an increase of 15c. In Boston the former range of $1.375 to $1.625 for hoisting engineers has been closed; top rate prevails.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready Mixed 1:2:4, 50 c.y. or more, delivered)
	Cloth Bags‡	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.65	$2.60	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.75‡	1.75‡	1.25‡	1.75‡	1.75‡	1.75‡	1.75‡	6.50
Birmingham	2.50	2.25	2.05	1.80	1.80	1.45	1.00	1.00	.90	1.15	5.45
Boston	2.75*b*	2.50*b*	2.30	1.10‡	1.10‡	.80‡	1.10‡	1.10‡	....	....	6.75*m*
Chicago	2.75	2.50	2.35	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	2.15‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.29	2.04	....	1.45*i*	1.45*i*	1.45*i*	1.60*i*	1.60*i*	1.70*i*	1.70*i*	6.85*i*
Dallas	2.30	2.05	1.85	2.00*p*	2.00*p*	1.50*p*	1.60*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.15	1.90	1.70	1.30	1.40	.81	1.45	1.45	1.14‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.90*n*
Los Angeles	2.82*b*	2.62*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	3.00	2.75	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	....	1.48	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	7.60*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.40*de*	1.40*de*	.90*de*	1.65*de*	1.75*de*	....	....	7.25
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.80‡	1.80‡	2.10‡	2.25‡	2.25‡	1.50	1.50	8.75
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.85*h*	.85*h*	.75*g*	.75*g*	7.50
San Francisco	2.72	2.52	2.20	1.36	1.36	1.36	1.46	1.46	....	....	7.63
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.50*o*

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice, in Montreal 5% if payment before 15th.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Norfolk, Va	1.65	1.60	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Northampton, Pa	1.55	1.50	Waco, Tex. (Plus 5c. Tax in Texas)	1.75	1.70
Independence, Kans	1.70	1.65	North Birmingham, Ala	1.70	1.65			

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT (Per ton, less than 80 penetration)		ASPHALT BINDERS—FLUXES (Per gal. 80–300 penetration)		CUTBACK ASPHALT (Per ton)		ROAD OILS (Per gal.)	ASPHALT EMULSION (Quick-breaking) (Per gal.)	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$75.00	$39.35	$2.25	$16.60*e*	$21.80*e*	$0.0645*e*	$0.0945*e*	$0.0684*he*	$0.0984*he*	$0.0584*e*	$0.0644	$0.0984
Baltimore	145.00‡	44.00‡	2.50	12.00	17.00	.045	.07	.055*h*	.125	.....	.....	.....
Birmingham	.....	24.50*j*	.....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	.....	.....	.....
Boston	80.00	47.00	3.25	13.00	18.00	.05	.08	.06*h*	.125	.....	.09‡	.12‡
Chicago	150.00	52.00	1.80*d*	14.00	18.00	13.00*g*	17.00*g*	.055	.105	.03	.08	.12
Cincinnati	112.00	37.50	.....	14.31	18.31	.10	.....	18.00	.....	.0525	.....	.08
Cleveland	110.00	37.25	2.80	15.25	20.50	.07	.08	.07*h*	.085*h*	.035	.08	.09
Dallas	.....	30.00	.....	12.00	17.00	.04	.07	13.00	18.00	.035	.05/.45	.07/.09
Denver	.....	27.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	.....	13.60*f*	18.00*f*	.0593	.0994	13.60	18.00	.0535	.0545	.0924
Kansas City	.....	44.00	.....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	.....	6.50*b*	15.00	6.50*b*	15.00*g*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	75.00	.....	3.62	14.60	21.25	.105	.1375	.101*h*	.121*h*	.07	.13	.16
New Orleans	.....	.....	.....	14.00*a*	19.00*a*	.055	.085	.06*h*	.09*h*	.....	.078	.....
New York	4.35*k*	68.00	2.70	12.50	17.50	.05	.075	.055*h*	.125*h*	.....	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.06*h*	.09*h*	.05	.06	.09
Pittsburgh	115.00	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	.....	14.00	19.00	14.00*g*	19.00*g*	.06*h*	.095*h*	.04	.09	.125
San Francisco	.....	70.00	.....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0475	.117
Seattle	.....	60.00*c*	.....	13.69	23.49	.....	24.09*g*	10.09/11.09	23.59/24.59	8.34*g*	.0575*i*	.1308

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3½x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in. *k* Per sq. yd.

(Continued on page 88)

Quick, COMPLETE TURNS CUT DIRT-HAULING COST!

Save time on narrow fills and roads . . .

Short turning radius of the Koehring Trail-Dump cuts your dirt-hauling costs — you can make complete, continuous turns on narrow roads and fills. Time is saved — back and forth maneuvering is eliminated — complete turns can be made on 21 foot wide fills or roads — sharp turns of greater than 90° — costs are cut because seconds are saved on every trip. Other important time-saving features are, instantaneous dump, easy loading body, high speed pneumatic-tired tractor, positive quick-closing doors.

KOEHRING COMPANY
MILWAUKEE, WISCONSIN

KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

(Continued from page 86)

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¾-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00*e*	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	....	....	2.40	....	....	....	....	....	2.15	....
Cleveland	2.10	2.15	3.40	2.55	....	....	....	....	....	....	....	....
Youngstown	....	2.15	....	....	....	....	....	....	....	3.00	....	....
Detroit	....	2.25‡	....	....	....	....	....	....	....	....	....	....
Gulf ports	2.45*a*	2.50*a*	....	....	2.85*a*	....	....	....	....	....	....	....
Pacific ports	2.70*a*	2.60*a*	....	....	2.90*a*	....	....	....	....	3.00	2.25	....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates alone. Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l. *e* Re-rolled price withdrawn; market unsettled with scrap advance.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS* Per 100 lb., ¼ in., base price: 15 tons or over *b* New billet	15 tons or over *b* Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd., carload lots: Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING—Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.39	.02½	.10	$21.00	$23.00	$1.70	$1.28	$0.1604	$3.04
Baltimore	3.60	2.85	2.70	.....	.10	20.50	22.50	1.58	1.20	.1496	2.70
Birmingham	2.10*a*	2.15	2.15	.02½	.10	19.50	21.50	1.68	1.26	.1586	....
Boston	4.00	2.73	2.58	$20 C.L.	.10	21.50	23.50	1.64	1.24	.1550	3.14
Chicago	2.10*a*	2.15	2.15	.03	.05	18.50	20.50	1.55	1.18	.1460	2.40
Cincinnati	3.68	2.51*c*	2.51*c*	.....	.05	20.50	22.50	1.54	1.17	.1451	....
Cleveland	3.58*g*	2.15	2.15	.02½	.10	20.50	22.50	1.54	1.17	.1460	....
Dallas	4.15	3.00	2.85	.....	.....	25.00	27.00	1.81	1.35	.1712	....
Denver	4.35	3.95	3.80	.....	.....	23.50	25.50	1.85	1.37	.1748	....
Detroit	3.80‡	2.60	2.45	.....	.10	22.50	24.50	1.56	1.19	.1478	2.81
Kansas City	4.03	2.51*c*	2.36*c*	.0	.05	18.50	20.50	1.66	1.25	.1577	2.86
Los Angeles	3.65*f*	2.65	2.50	.02½	.05	23.00	27.50	1.81	1.35	.1712	3.65
Minneapolis	3.80‡	2.48*c*	2.48*c*	.0	.10	21.50	24.50	1.68	1.26	.1586	2.73*d*
Montreal	3.80	2.65	2.55	.....	.....	26.00	28.50	2.99	2.08	.319	3.95
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.71	1.29	.1522	2.875
New York	3.75	2.39	2.39	.....	.10	20.50	22.50	1.64	1.24	.1557	2.74
Philadelphia	3.55	2.66	2.56	.....	.....	19.50	21.50	1.59	1.21	.1505	2.72
Pittsburgh	2.10*a*	2.15	2.15	.02½	.10	21.50	24.50	1.47	1.13	.1388	2.40
St. Louis	3.47	2.39	2.39	.0	.05	20.50	24.00	1.57	1.19	.1487	2.70
San Francisco	4.00	2.525	2.375	.02½	.10	23.50	25.50	1.81	1.35	.1712	3.25
Seattle	2.70*e*	2.40*e*	.....	.....	.....	25.50	27.50	1.81	1.35	.1712	2.90*e*

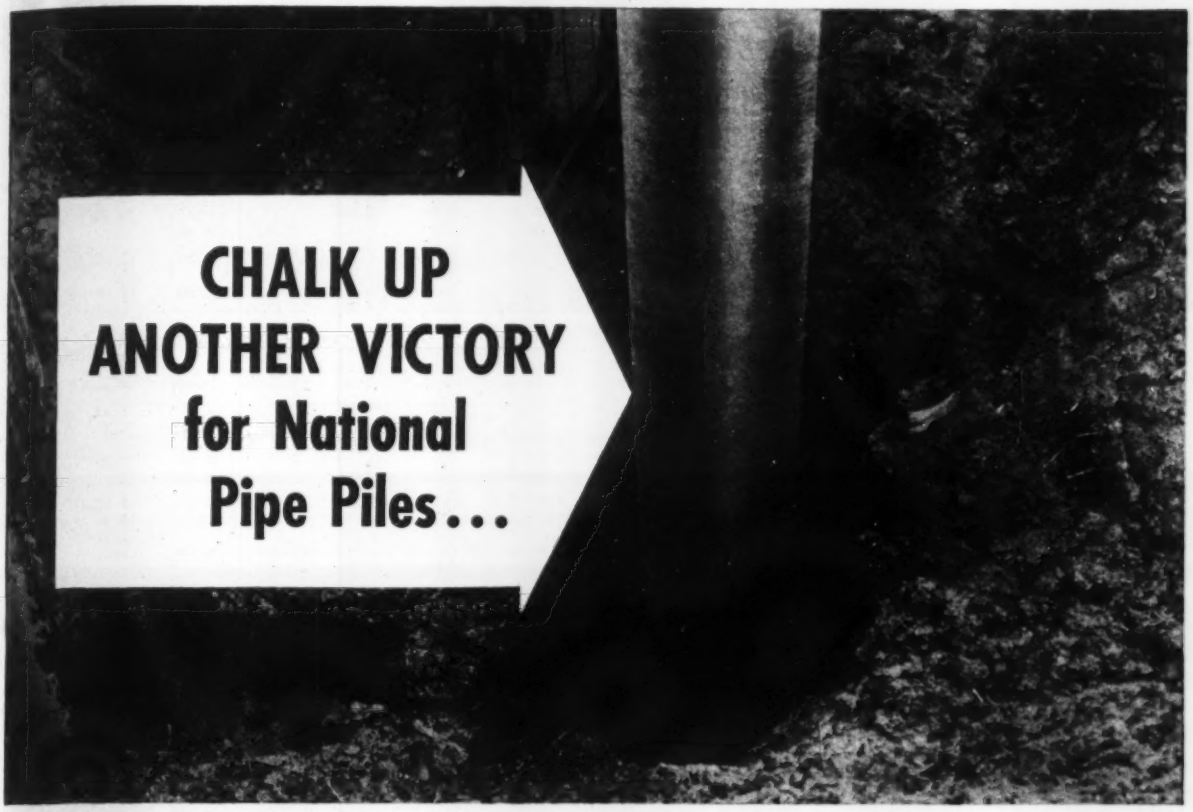
‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. * High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, 8 in., s.s.	delivered 12 in., s.s.	ASTM 24 in., d.s.	C13–35 36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, 6 in.	f.o.b. 8 in.	CONCRETE SEWER PIPE Per ft., delivered: ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h*: 1 to 3 in., Black %	Butt Weld 3½ to 6 in., Galv. %	Black %	Lap Weld Galv. %
Atlanta	$49.40	$0.26*bc*	$0.468*bc*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.625	62.2	54.2	59.7	51.2
Baltimore	52.80	.30	.55	2.30	6.80	110.00	150.00	.40	1.60	65.5	57.5	63.0	54.5
Birmingham	45.00	.25	.45	1.625	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.294	.567	2.16	6.15	199.00‡	288.00‡	.50	2.50	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.259	.4995	1.935	5.6375	75.00	120.00	.60	1.90	65.9	57.9	63.4	54.9
Cleveland	54.24	.224	.432	1.665	5.0225	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.265	.477	1.728	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	.....	.....	58.4	50.4	55.7	47.2
Detroit	54.24	.147	.2835	1.215	4.70	66.45	111.40	.162	1.125	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	56.8	47.8	54.3	44.8
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.15	5.10*e*	135.00‡	260.00‡	.48	1.92	.....	.....	.....	.....
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.21	.405	1.75	5.05	100.00	160.00	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.15	.504	1.728	3.96	85.00	170.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.45	2.50	.....	.....	.....	.....
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.45*f*	1.40*f*	.....	.....	.....	.....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N. J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¾ in., 8½c.; 1 in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest price at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld — 1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld — 2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

(Continued on page 90)



HERE IS THE type of condition which had to be penetrated to provide solid footing. 8300 feet of 12¾-inch NATIONAL *Seamless Pipe Piles were used. Length of piles could not be predetermined, because of irregular underground rock ledges running along the cliff. Photos courtesy of The Port of New York Authority. General Contractor, Wood & Hagen, New York City.*

WORK MOVING STEADILY AHEAD on the south section of approach to George Washington Bridge from Harlem River Speedway, New York. Piers founded on NATIONAL *Pipe Piles driven through rip-rap to refusal on bed rock.*

Penetrate heavy rip-rap fill to gain solid footing for new George Washington Bridge approach

HERE is more proof that NATIONAL Seamless Pipe makes the most dependable piling for the toughest foundation conditions. In setting foundations for this new approach to the George Washington Bridge from Harlem River Speedway, New York City, engineers encountered rip-rap and boulders, one of the most uncertain and difficult types of fill material to penetrate.

But the job went ahead right on schedule. Engineers had foreseen the tough driving conditions and had wisely specified NATIONAL Seamless Pipe. And today this important approach stands complete, firmly founded on 8300 feet of NATIONAL Pipe Piles, driven to refusal on solid bed rock.

For your next foundation job, use NATIONAL Pipe Piles. They penetrate the toughest conditions. They offer greater supporting strength. They cost less for deep and difficult and uncertain penetration. They can be inspected full length, after driving. They are recognized by leading building codes.

Write today for Bulletin No. 27, which gives complete engineering information and descriptive details on many interesting projects employing NATIONAL Pipe Piles.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

(Continued from page 88)

LUMBER, TIMBER, PLYWOOD—PER M FT. B.M., CARLOAD LOTS F.O.B.

	SHORT LEAF YELLOW PINE AND DOUGLAS FIR									LONG LEAF Y. P.		PLYWOOD*
	All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face)									Merchantable grade up to 20 ft.		Rail freight increment (See note for base price)
	All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)											
	1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10, S4S	3x12, R3A	6x12, R3A	12x12, R3A	2x12, R3A	12x12, R3A	5/16"
Atlanta	**$20.00**	**$20.00**	**$19.00**	**$20.00**	**$20.50**	**$22.00**	**$27.00**	.....	.....	**$38.50**	**$50.50**	**$17.75**	$21.60
Baltimore	**28.00**	**29.50**	**34.50**	**33.50**	**34.00**	**35.00**	**42.50**	.....	.....	65.00	67.00	**17.35***g*	21.15*g*
	30.00	*30.00*	*32.00*	*31.00*	*32.00*	*33.00*	*42.50*	*$42.50*	*$38.00*	.....	.....	.....	.....
Birmingham	**22.50**	**23.50**	**22.00**	**21.00**	**22.00**	**23.00**	**37.00**	**36.00**	**36.00**	.....	.....	**16.25**	19.85
[1]	25.50	25.50	29.00	27.00	29.00	40.00	60.00	.....	.....	52.00	60.00	.....	.....
Boston	32.00[2]	32.00[2]	34.00[2]	34.00	53.00[1]	63.00[1]	77.00[1]	.....	.....	**77.00**	**77.00**	**17.35***g*	21.15*g*
	29.00	*29.00*	*34.00*	*34.00*	*36.00*	*36.00*	*45.00*	*45.00*	*50.00*	.....	.....	.....	.....
Chicago	**33.00**	**34.00**	**34.00**	**33.00**	**34.00**	**35.00**	**50.00**	.....	.....	80.00	90.00	13.15	16.05
	37.00	*37.00*	*40.00*	*39.00*	*40.00*	*41.00*	*44.00*	*45.00*	*45.00*	.....	.....	.....	.....
Cincinnati	**31.50**	**33.00**	**30.50**	**31.00**	**32.00**	**35.00**	**44.50**	.....	.....	53.00	56.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*46.00*	*46.00*	*46.00*	.....	.....	.....	.....
Cleveland	**33.00**	**33.50**	**33.00**	**33.50**	**35.00**	**37.00**	**44.00**	46.00	46.00	80.00	80.00	16.65	20.25
Dallas *e*	**28.50**	**32.00**	**31.50**	**28.50**	**30.00**	**32.50**	**53.50**	**52.50**	**52.50**	63.50	71.00	13.90	16.95
Denver ‡	44.00[4]	42.00[4]	40.00[4]	43.00[4]	48.00[4]	43.00[4]	48.00[4]	60.00[4]	71.50[4]	.....	.....	9.90	12.05
Detroit	**35.00**	**35.00**	**35.00**	**35.00**	**38.50**	**42.00**	**46.00**	.....	.....	43.50	58.00	16.25	19.85
	.....	.....	.....	.....	.....	*46.00*	*47.00*	*54.00*	*54.00*	.....	.....	.....	.....
Kansas City	**29.00**	**31.00**	**30.00**	**28.50**	**29.00**	**31.00**	**35.00**	.....	.....	55.00	60.00	12.25	14.95
	29.00	*30.00*	*30.00*	*28.50*	*29.00*	*30.00*	*35.00*	*39.00*	*39.00*	.....	.....	.....	.....
Los Angeles *a*	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	.....	.....	**9.35***gh*	11.35*gh*
Minneapolis *b*	47.00[5]	47.00[5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	**12.05**	14.70
‡	*38.00*	*38.00*	*39.00*	*39.00*	*39.00*	*39.00*	*59.00*	*59.00*	*59.00*	.....	.....	.....	.....
Montreal *k*	*44.00*	*44.00*	*49.00*	*47.00*	48.00	58.00	84.00	.....	.....	155.00	165.00	.....	.....
	40.00	*40.00*	*40.00*	*40.00*	*40.00*	*41.50*	*41.00*	*40.00*	*39.00*	.....	.....	.....	.....
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	.....	.....	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	.....	.....	.....	.....	.....	.....
New York ‡	**38.00**	**39.00**	**37.00**	**38.00**	**38.00**	**39.00**	**42.00**	.....	.....	80.00*f*	82.50*f*	**17.35***g*	21.15*g*
‡	.....	.....	*45.00*	*45.00*	*45.00*	*45.00*	*45.00*	*47.50*	*47.50*	.....	.....	.....	.....
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	.....	.....	**55.00**	**57.50**	**17.35***g*	21.15*g*
	35.00	*36.50*	*39.00*	*38.25*	*39.00*	*39.00*	*44.00*	*32.00*	*32.00*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	.....	.....	.....	.....	**17.00**	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis ‡*c*	**35.00**	**36.00**	**33.00**	**32.00**	**33.00**	**34.00**	**48.00**	*52.00*	*52.00*	**73.00**	**72.00**	**13.90**	16.95
San Francisco *d*	*22.50*	*22.00*	*22.50*	*22.50*	*21.50*	*21.50*	*23.50*	*23.50*	*23.50*	.....	.....	7.30*g*	8.90*g*
Seattle	*22.00*	*22.00*	*22.00*	*22.00*	*22.00*	*22.00*	*27.00*	*27.00*	*27.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Pine. [8] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft. *k* These are October prices; unable to obtain November quotations.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on 5/8", $74.00; on 3/4", $81.50; price includes oiling and sealing charges. For other centers add rail freight increment from table for proper size. For resin dipped treatment, add $10.00 per M. *g* Lower rate by water shipment. *h* 50,000 lb. minimum.

* Plywood prices to hold for balance of year, but many manufacturers are out of market. Will not take future orders.

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS — Discounts from jobbers list, Sept. 15, 1928, Single or Double Thickness		EXPLOSIVES — Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*	
	A quality	B quality		
Atlanta	75%*d*	75%*d*	$0.15	
Baltimore	83%*d*	82%*d*	.15	
Birmingham	89%	90%	.105	
Boston	82%*d*	82%*d*	.15	
Chicago	79%*d*	79%*d*	.15	
Cincinnati	79–10%*d*	79–10%*d*	.15	Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%
Cleveland	79–10%	79–10%	.19	
Dallas	80%*d*	80%*d*	.165	
Denver	76–10%*d*	76–10%*d*	.15*e*	
Detroit	79–10%*d*	79–10%*d*	.15	
Kansas City	79–10%*d*	79–10%*d*	.155	
Los Angeles	88%	90%	.1575	
Minneapolis	76%*a*	76%*a*	.15*b*	
Montreal	70–10%*b*		.17†	
New Orleans	80%*d*	80%*d*	.16	
New York	82%*d*	83%*d*	.20*f*	
Philadelphia	89–10%	90–10%	.15	
Pittsburgh	79%*a*	79%*a*	.1425	
St. Louis	79–10%*d*	79–10%*d*	.155	
San Francisco	78%*d*	83%*d*	.155	
Seattle	85%	88%	.1575	

a Disc. from list Sept. 15, 1938 *b* Also less 6% tax exemption. *d* Discount from jobbers' list Aug. 15, 1938.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. *f* In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla.	$0.105	$0.14	$0.16
W. of Miss., to Rocky Mtn. States, and Fla	.11 –.12	.135 –.15	.155 –.17
Rocky Mtn. States	.11 –.1325	.13 –.145**	.15 –.165**
Pacific N. W. States	.1075–.115	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1175	.135 –.1475	.155 –.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf — Barge	Short Leaf — Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6' x 8" x 8' Untr.	6' x 8" x 8' Tr.	7' x 9" x 8'6" Untr.	7' x 9" x 8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*ab*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.25*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60*a*	1.50	2.03*a*
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90*bef*	....	....	1.95*af*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

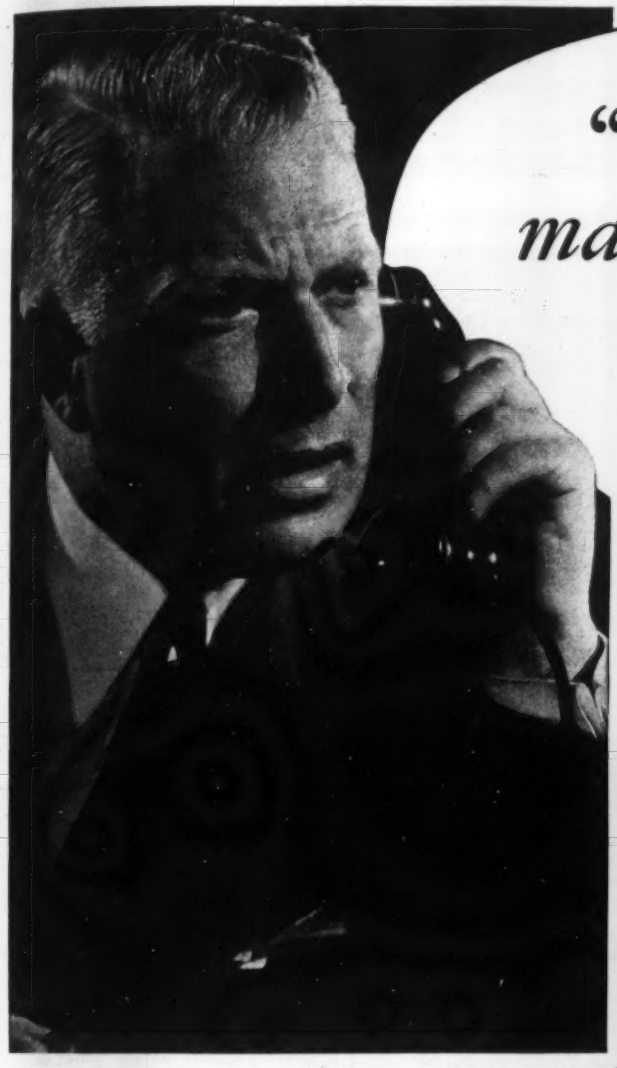
Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6' x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb.	$2.00–2.85
Chlorine cylinders, liquid, per lb. delivered	.0525
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	22.00–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb.	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb.	4.75

(Continued on page 92)



"what! another *materials handling* accident... can't we *do something* about them?"

Yes you can!

Replace Old-fashioned Dangerous Lifting Elements with Macwhyte Braided Wire Rope Slings

● The cost of a *single* accident can be *many* times the cost of replacing dangerous lifting elements! It doesn't pay to take chances; it *does* pay to have modern, safe, dependable equipment at all times.

For handling materials there's no better, no safer equipment than Macwhyte Braided Wire Rope Slings.

The secret of their safety lies in their patented braided construction made from right and left lay endless Monarch Whyte Strand wire ropes. These slings in addition to their safety features have:

unusual strength,
"hug" the load tight,
speed up handling.

They're extremely pliable,
light in weight,
easy to handle.

AND because they do the job easily, safely, speedily, month after month, they're ECONOMICAL, too!

For these reasons you find Macwhyte Braided Wire Rope Slings on duty in many of America's largest manufacturing plants.

MACWHYTE COMPANY
Manufacturers of
Wire Rope and Braided Wire Rope Slings
Main Office: KENOSHA, WISCONSIN
New York . . Pittsburgh . . Chicago . . Ft. Worth . . Portland . . Seattle . . San Francisco
(Distributors throughout the U. S. A.)

Member National Safety Council

Furnished Without Obligation:

1 *Expert Consulting Service.* Write us about *your* handling problems. Our engineers will study them, help you solve them, show you how to get better service at lower cost. This consulting service is furnished without obligation.

2 *How to Handle Loads Safely* . . . an on-the-job booklet showing how Macwhyte Slings solve materials handling problems of every kind, every day. Send for this free booklet.

NO. 396

MACWHYTE
Braided WIRE ROPE *Slings*

(Continued from page 90)

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	Structural clay tile — partition — scored, per M. lots of 2,000 pieces or over, 3x12x12 in.	4x12x12 in.	8x12x12 in.	Structural clay tile — load bearing — scored, per M. lots of 2,000 pieces or over, 8x12x12 in.	10x12x12 in.	12x12x12 in.	Brick, per M. in quantity, Common backing	Straight hard	Lime, per ton, Hydrated finishing	In paper Common hydrated	Carload lot Pulverized or lump
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$24.00	$15.50	$15.50
Baltimore	74.00	80.00	165.00	190.00	240.00	290.00	13.00*k*	16.00*k*	18.50	14.50	2.50*m*
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	19.00	25.00	17.50	2.00*o*
Boston	82.10*a*	87.60*a*	164.20*a*	186.10*a*	243.20*a*	277.90*a*	17.00*i*	20.00*i*	19.00	12.50	3.10*p*
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	.....
Cleveland	54.50	58.00	109.00	130.50	175.50	200.50	16.00	16.00	16.00*j*	14.00*j*	2.75*j*m
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	.95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*j*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.00	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.00	15.00	16.50	.....	17.50
Minneapolis	66.70	71.20	122.50	141.30	149.30	209.40	13.10	15.10*g*	21.00	16.00	19.00
Montreal	72.20*a*	77.50*a*	142.50*a*†*t*	76.00*a*	165.80*a*	248.70	20.75	28.00	23.50	17.00	1.75*l*o
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00	193.30*h*	238.80*h*	295.60*h*	13.00	.....	20.00	14.00	18.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	296.60	15.00*s*	18.00*s*	15.50*q*	9.55*q*	12.05*q*
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*m*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6 x 12 x 12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

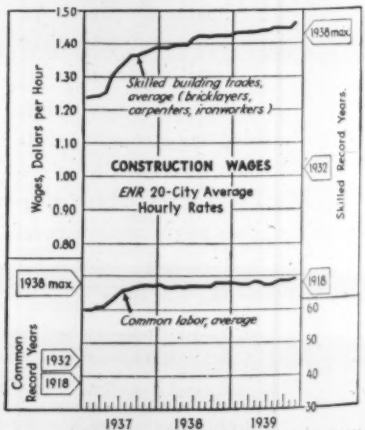
	Red lead, per 100 lb. in 600-lb. (Approx.) bbl. Dry *a*	White lead, per 100 lb. in oil	Ready-mixed paint, per gal., drums, Graphite *b*	Aluminum *c*	Ferric Oxide *d*	Roofing supplies Carload lots f.o.b. factory, Rolls, slate surfaced, 85–90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl per ton
Atlanta	$9.25	$13.125	$1.30	$2.25	$1.20	$1.71	$1.65	$1.65	$0.36	$26.00
Baltimore	9.00	12.75	1.70	2.45	1.95	2.20	2.75	2.75	.45	27.50
Birmingham	9.25	13.125	2.35	2.35	1.85	1.84	1.73	1.73	.45	27.00
Boston	9.00	12.75	1.70‡	2.20‡	1.75‡	1.70‡	1.80*h*‡	1.80*h*‡	.45‡	20.00‡
Chicago	9.00	12.75	1.96	2.63	1.68	1 40*hf*	1.53*hf*	1.53*hf*	.26*f*	21.00*f*
Cincinnati	9.00	12.75	1.45	2.50	1.40	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	9.00	12.75	1.90	2.60	1.40	1.55	1.55*h*	1.55*h*	.32	22.00
Dallas	9.00	13.50	1.88	2.11	....	2.75*h*	2.50*h*	2.50*h*	.60	....
Denver	9.50	13.25	1.65	2.40	.17*l*	2.45	4.00	3.00	.35	18.00
Detroit	9.00	12.75	2.00	3.00	1.75	2.40	2.75	2.75	.35	27.50
Kansas City	9.00	12.875	2.15*g*	2.40*g*	1.67*g*	1 93	2.09	2.09	.25	25.00
Los Angeles	9.25	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	....
Minneapolis	9.00	12.875	....	....	....	1.58*i*	1.45*h*i	1.45*h*i	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68*k*
New York	9.00	12.75	1.88	2.55	1.60	1.63	1.45*h*	1.45*h*	.23	24.00
Philadelphia	9.00	12.75	....	....	....	1.92*e*	1.99*h*e	1.99*h*e	.41*e*	21.00
Pittsburgh	9.00	12.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	9.00	12.75	1.70/1.90	2.50/2.75	1.50/1.90	1.50	1.50	1.50	22	21.00
San Francisco	9.25	13.00	1.80	2.75	1.10/2.00	1.66	1.90	1.90	.325	20.50
Seattle	9.25	13.25	1.80	3.00	2.20	2.35	1.46/2.14	1.95	.63	24.75*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* per 100 lb. *l* per lb.

SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor, Building	Common Labor, Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.25	.5625	.5625
Birmingham	1.50	1.125	1.25	1.125	1.00	.30/.40*a*	.30/.40*a*
Boston	1.50	1.375	1.50	1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.525	1.00/1.525	1.625	.60/.75	.60/.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.50*b*	1.43*b*	....	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.50	1.50	1.55	.60/.75	.60/.75
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.50	1.20	1.50	1.50	1.40	.40	.40
New York	1.90*b*	1.75*b*	1.925	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65*b*	1.25	1.65	1.50	1.565	.60	.60
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.25	1.75	1.57/2.00	1.58	.45/.875	.45/.875
San Francisco	1.75*c*	1.25*f*	1.50	1.50	1.60*c*	.81	.65
Seattle	1.60*c*	1.25	1.50*c*	1.50*c*	1.60*c*	.90*c*	.90*c*
Montreal*	.80	.70	.75	.65	.80	.45	.40

a PWA. *b* 7 hr. day. *c* 6 hr. day. *d* 35 hr. wk. *e* 30 hr. wk. *f* Working under "stop-gap" agreement. * Possibility of change during November.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) $1.444

ENR Common Average: $0.685

FILLING IN A BAY TO GIVE SKYLINERS ELBOW ROOM

MORE THAN PLEASED
—was the sentiment of Mr. Ben Wells, General Superintendent, with the work done by the Gardner-Denver UMB Wagon Drill, and WBG Diesel-driven portable air compressors. And that's what you'll say, too, when you put Gardner-Denver equipment on the job . . . for they'll give you thousands of hours of perfect service...save you money in low-cost operation and low maintenance. You'll agree that they're the best equipment for big jobs, tough jobs—every job!

PERFORMANCE LIKE THIS SHOWS YOU WHY IT PAYS TO CHOOSE GARDNER-DENVER EQUIPMENT

When airports spread out, something often moves aside. This time it's San Francisco Bay. In order to enlarge the San Francisco Airport, the bay adjoining is being rapidly filled in with 600,000 yards of material.

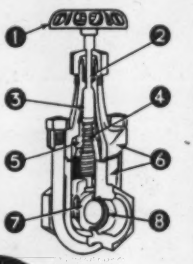
The Macco Construction Company, handling the job, called on a Gardner-Denver UMB Universal Mounting Wagon Drill and two WBG-315' Diesel-driven portable air compressors to keep up the quota of 4500 yards of fill per day.

A record footage run of 525 lineal feet in eight hours, averaging approximately 430 feet per eight-hour shift—that was what the UMB Wagon Drill accomplished. Working one eight-hour shift per day, it kept a 2½ yard shovel busy eighteen hours a day, loading a fleet of twelve 16-yard trucks which traveled continuously from the quarry to the airport. Get complete facts and operating data about these UMB Wagon Drills and Portable Air Compressors. Write us today for full information. Gardner-Denver Company, Quincy, Illinois.

GARDNER-DENVER 80th ANNIVERSARY YEAR

JENKINS
IRON VALVES
COST LESS
TO USE!

Economy Features of this U-Bolt Gate



1 Perfect Grip Handwheel
2 Extra Deep Stuffing Box
3 Easily Cleaned Bonnet Chamber
4 Liberally Threaded Bronze Spindle
5 Renewable "Bonnet-Saver-Bushing"
6 Heavy Duty Bonnet and Body
7 Wide Gauge Reversible Wedge
8 Bronze Seat Rings—Expanded in
9 Iron Exceeds A.S.T.M. Standards

Fig. 42-A—150 lb. Bronze Mounted U Bolt Gate Valve

JENKINS BROS., 80 White Street, New York, N.Y.
Bridgeport, Conn.; Atlanta; Boston; Chicago; Houston; Philadelphia; Montreal, Canada; London, England

(Continued from page 43)

MEN AND JOBS

THOMAS L. CORDLE, town manager of Fuquay Springs, N. C., and a graduate of the Engineering College of the University of North Carolina, has resigned to become town manager of Apex, N. C. Cordle succeeds W. P. KANTO, who resigned to take a similar position at Norton, Va. (*ENR*, Oct. 26, p. 102). ROBERT G. JOHNSON, Kipling, N. C., graduate of North Carolina State, will take Cordle's place at Fuquay Springs.

H. A. DIXON, chief engineer of the Western Region, Canadian National Ry., has been appointed chief engineer of operation for the entire National system. The appointment is effective Jan. 1, and he will succeed C. B. Brown, who is retiring on pension. Dixon is a graduate of the University of Toronto and joined the Canadian Northern Ry. in 1903, shortly afterward becoming resident engineer.

H. O. PETERS is now working as resident engineer for the U. S. Engineers on Evansville, Ind., flood control project. Before going to Evansville, Peters had been at Louisville, Ky., in the flood control section of the U. S. Engineers Office and previous to that had worked for seven years as resident engineer on various flood control and navigation projects in Florida.

LIEUT. JAMES D. LANG, resident engineer for the U. S. Engineers at Mud Mountain Dam under construction near Seattle, Wash., has been transferred to Fort Lewis for active duty. He will be succeeded by FRANK E. PREBLE, civilian engineer from Baltimore.

MAJ. FRED BASS has replaced LIEUT. COL. D. O. ELLIOTT as district engineer, U. S. Engineers, at Cincinnati, O. In his new work Bass will have control of flood control work upon which $35,000,000 is to be expended during the next two years. Lieut. Elliott has been transferred to Fort Devens, Mass. (*ENR*, Nov. 2, 1939, p. 596).

LEONARD COBLENTZ, Quakertown, Pa., has been appointed an engineer with the Pennsylvania Department of Agriculture.

CAPT. HANS KRAMER, army engineer in charge of construction at Conchas Dam and Caddoa Dam, has been transferred to the Panama Canal Zone. A successor to Captain Kramer has not been named.

W. C. LEFEVBRE, examining engineer in the PWA regional office at San Francisco, has resigned to accept a position as chief engineer of the Hassayampa project in central Arizona.

SID SMITH, deputy state engineer with the Arizona State Highway Department, has resigned and his position has been taken by FRED GRANT, district engineer. The highway department has re-zoned the state into two districts instead of three to eliminate one district engineer. Joe DeArozena, who has been appointed to the newly created position of engineer of contract construction. CY PERKINS and J. R. VAN HORN are to head the two districts. W. L. PENDLETON, assistant engineer of plans, has resigned after 17 years with the department.

JOSEPH EVANS, assistant director of the Omaha PWA regional office has been transferred to new duties in Washington, D. C. Evans joined the PWA at Washington in 1933 and was soon transferred to Omaha as project engineer in charge of the Loup River power project. He became assistant regional director when eight states were placed under one regional office.

A. B. CURRY has succeeded E. M. WILLIAMS as city manager of Coral Gables, Fla. Curry was formerly public service director.

GEORGE F. EMERY, chief building inspector for Detroit, is conducting a class at Wayne University for students studying the Detroit building code.

WILLIAM G. GROVE, associate engineer with the Connecticut State Highway Department, has been appointed part-time instructor at Hillyer Junior College, Hartford, Conn.

ROGER B. MCWHORTER, civil engineer and chief engineer of the Federal Power Commission, has been appointed a member of the International Joint Commission, which supervises the United States-Canada boundary. The appointment was made by President Roosevelt and he replaces EUGENE LORTON, Tulsa, Okla.

G. E. WRIGHT, civil engineer, is now representing Solomon & Keis, consulting engineers of Troy, N. Y., as resident construction engineer on a sewage and garbage disposal project at Watervliet, N. Y. Wright was once city engineer, superintendent of public works and superintendent of water at Corning.

Weighs 3½ to 9 tons: Travels 4¼ miles per hour: Steers like a tractor: Power 38 to 56 H.P.: Swings 5 r.p.m.: Hooked Conical Rollers (no center pintle): Twin, positive rope crowd: 28 Ball and Roller Bearings: Automatic Lubrication.

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N. Y. He was also in private consulting practice at Corning for a time.

ARNOLD PETERSON, landscape engineer for North Carolina State College, Raleigh, has been appointed to a similar position with the city of Raleigh.

JOHN C. SPRAGUE, chief of the concrete and soils section, U. S. Engineers Office, Huntington, W. Va., has resigned to join the Dravo Corp. as development engineer in the Keystone division. His offices will be located in Pittsburgh.

HOMER R. TURNER, Windsor, Conn., and HARRY C. CARSTENS, Branford, Conn., have been appointed associate highway engineers with the Connecticut State Highway Department.

J. J. KENNEDY, assistant engineer with the United States Indian Service at Coolidge, Arizona, has been transferred to Parker to assist with the designing of an irrigation project.

PHILIP DU SAULT, Coeur d'Alene, Idaho, has been employed by the Idaho State Highway Bureau as roadside improvement engineer for ten counties in the northern part of the state. His headquarters will be located in the city of Moscow.

A. J. TRICE, C. M. COLTON and J. W. MCWHIRTER are directors of the Gulf Coast Construction Co., which was recently chartered at Tampa, Fla.

LIEUT. JAMES MCCORMACK, JR., assistant project engineer on construction at Sardis Dam, has been transferred to Fort Benning, Ga., to assist in the formation and training of a new engineering regiment as part of the recently authorized expansion of the United States Army.

S. T. COBB, WPA project supervisor in Lee County, N. C. and stationed at Sanford, has been transferred to Smithfield in Area No. 3 to be office engineer.

ANTONIO ROBERGE, civil engineer of Quebec City, Quebec, has been appointed engineer of Drummondville, Quebec, to succeed Romeo Morrisette, resigned.

JOSEPH C. CASSELL, Norristown, Pa., and B. W. MCCLURE, Bunola, Pa., are new project engineers with the Pennsylvania State Highway Department. JOHN H. LEWIS, Indiana, Pa., has been appointed to the position of district plans engineer.

CARL T. JACOBSON, Bradford, Pa., has been added to the engineering staff